THE

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MONOPOLY AND DECENTRALISATION.

AT various meetings held by the allied cable companies during the past month, speeches have been made which, in the general interest, deserve some consideration. For many years they have fallen upon debateable ground, and the subjects publicly discussed, and upon which grave issues depend, have not until recently received well-deserved adverse criticism. If the questions are ever to be determined and work is to be kept in British, and not driven, as we learn from Mr. Audley Coote, into foreign, hands, they had better be considered in such a manner as will enable us to retain a valuable telegraphic centre in London. We gather from the Marquis of Tweeddale that nothing will be heard of the German Atlantic cable—presumably extending from the Azores to some point in the North Atlantic—for some years to come, and we may be thankful for this breathing space. We presume in the year 1,900, when we understand the agreement terminates between the Anglo-American Telegraph Company and the German Government, that the second decentralising cable will be laid, the first section of which, we learn, may be placed between Emden and Vigo, withdrawing the Eastern German traffic in that direction. We do not fancy that such a prospect is one the British Postal Officials anticipated, for we think we may say the shrinkage of any public revenue cannot be viewed with equanimity by the taxpayers of this country. The second question which seems to call for consideration is the subsidising of cables which are to be laid to places which are already connected. The French Government have paid little heed to the argument laid down by the Marquis of Tweeddale, and his lordship's contention at a meeting of the Atlantic Company, coupled with the laying of German Atlantic cables, the first section of which, as already notified above, will probably be the Emden-Vigo cable, cannot be said to be very happy. Nor do we quite follow such a complete change of opinion as seems apparent when the methods used by the projectors of the first Eastern cable system (of which Lord Tweeddale is the President, and with which he has been connected for more than 20 years) and his present arguments are compared. Mr. J. C. Parkinson, in his narrative and diary, published in 1870, and called "The Ocean Telegraph to India," tells us, in the introductory pages, of the difficulties besetting the enterprise, of propositions to the Secretary of State for India, and the refusals of our Government to co-operate with the projectors of the scheme, or to give a guarantee, and the ultimate initiation of the British Indian Submarine Telegraph Company. Lord Cranborne, now the present Marquis of Salisbury, replied to an offer from Mr. Shuter, of the Telegraph Maintenance Company, saying "the Governments of other countries have recently, at considerable cost to themselves, assisted in the completion of the land lines of communication between this country and India." He said: "They were induced to incur this cost n

prospect of a traffic at present not more than sufficient to repay it, and he could not justifiably join in setting up a competition which, for a time, would have the effect of wholly frustating the expectations they were led to entertain." We think we thus find that the initiators of the system which the Marquis of Tweeddale represents tried the methods to which he now objects. They failed, and deservedly so, as it was apparent the British Government could not enter into and break down a struggling line belonging to other Governments. We do not know that the projectors of the Eastern cables had any compunction whatever. They were determined to lay their cables, and did so.

The Pacific and other projected connections do not bring into the question the most important consideration, viz., international complications and distrust, nor do they threaten other struggling enterprises. They are purely British, and concern this country or colonies owning allegiance to us. Their opponents are enormously rich, and pay annually large dividends and set aside enormous sums to swell already large reserve funds. We find that in all cases the demand for increased telegraphic facilities has come from the colonies, and this is easily understood, as the question is always vital to small places which are a great distance from their markets. From Australia, Canada, the Cape and the West India Islands the cry is now heard, just as the East Indians joined in with the Eastern group. The laying of new cables will not have the ill effect anticipated by the Chairman of the Eastern Company any more than the laying of the cables to the East caused the collapse of the land-lines looked for by Lord Cranborne. Whether the British Government had given subsidies or not, the result would have been the same. The Colonies are growing in all ways, and the future need of more lines is more than apparent; and we are of the opinion that the wolf labelled "Competition," and other such stock will-o'-the-wisp phrases are merely to cover the desire and determination to prevent the entry of our Government, or any other body, into the laying of submarine cables as long as possible. We again say the French Government have done well to assist in throwing off an irksome control, and we think the German and the United States Governments will soon follow suit.

HOW EXTENSIONS ARE PREVENTED.

It is much to be regretted that the Hull Town Council have seen fit to reject the scheme of the Electric Lighting Committee to provide for extensions. The existing Corporation Works have achieved considerable success. During 1895 a profit of £1,263 was made, and the cost of production was materially reduced. But it is clear that with the present low pressure system the area of supply is somewhat limited, and with the laudable desire of conferring the benefits of electricity upon a wider neighbourhood, and the equally rational wish to improve the position of the supply business, the Electric Lighting Committee drew up a scheme of extension which involved an outlay of £42,000. At the monthly meeting of the Corporation, however, held last week, the proposed extensions were tabooed. This refusal to sanction the enlargement of the electric lighting system was mainly due to the hostile attitude taken up by Dr. Holder, and as this gentleman for a considerable period acted as chairman of the Electric Lighting Committee, his objections are no doubt deserving of some consideration. But a careful perusal of Dr. Holder's arguments leads us to think that his lengthened association with the electric lighting work has not been as profitable to him as we should have imagined. Or it may be that he has become so wedded with the present system that he sees no virtue in others. He finds fault with the Committee for not seeking outside expert assistance. But this is surely unnecessary. We were certainly of opinion that Hull had been well supplied with expert assistance at the hands of its Borough electrical engineers; indeed, the most remarkable feature about the existing works which Mr. Holder very properly extolled, is that they were almost, if not the first, in this country to be designed and laid out by a Borough electrical engineer. If the Town Council of Hull have been led to reject the projected extensions solely through Dr. Holder's arguments, they have committed a very grave error. As an example of the objections he put forward, we may quote the following: "When the chairman said that he was not going to put the cables in culverts he (Dr. Holder) condemned his scheme at once." If the late chairman of the Electric Lighting Committee had made more use of his opportunities, he might have discovered that cables are laid direct in the ground in some singularly successful systems. But though one might appreciate technical reasons against cables laid direct in the ground, we are completely astounded at the objection put forward by Dr. Holder, whom we had every reason to believe possessed greater electrical knowledge than the majority of electric light committee men. He says: "If there should be a perforation of a high tension main, and if it became uncovered, the electricity would come through the fissure and run to the tram metals, and kill any animal with iron shoes that came in contact with it." It is a great pity that such exaggerations should be uttered by one occupying the position of Dr. Holder. They do not redound to the credit of his attainments, and they have certainly the effect of retarding the development of public supply. It is to be sincerely hoped that the Corporation of Hull will show more belief in the capacity of their Borough electrical engineer; they would certainly be justified in paying less heed to Dr. Holder, if the speech he made at the last meeting represents his true knowledge of electric lighting matters.

A Great Legal Suit. A JUDGE, twelve jurymen, two members of the bar, and numerous occupants of the public gallery, were engaged at the Guildhall, on Tuesday last, from half-past ten to half-past three in hearing a case which involved the sum of £22. The Farringdon Works, Limited, sued the I.E.S. Accumulator Company for the balance of an account due for the supply of two tons of oxide of lead. The defence set up was, that the commodity supplied was bad, and inasmuch as 1,600 accumulator plates had been spoilt by using it, they counter-claimed for damages, which, if it served no other purpose, was useful in making the case complicated. There was a good deal of evidence of a conflicting character, and a great display of forensic eloquence, but the defence was gradually worn down, and by half-past three the jury returned a verdict for the plaintiffs on all counts, and the great suit was ended.

Nikola Tesla and Matrimony.

THOSE who are acquainted with the History of Socrates must have read how, upon his making a discourse concerning Love, he pressed his point with so much success that all the bachelors in his audience took the opportunity of getting married on the first occasion, and all the married men immediately took horse and galloped home to their wives. We think that it is rather a pity that Mr. Tesla did not hear Socrates on this subject for his own good, though for the good of science in general we much prefer that he should be reminded of it a score of centuries or so later. According to a New York daily paper, Nikola Tesla is a disciple of the Baconian theory, that the man who marries gives hostages to fortune. "I do not believe," he says, "that an inventor should marry, because he has so intense a nature and so much in it of wild passionate qualities that in giving himself to a woman he might love, he would give everything, and so take everything from his chosen field." It can readily be imagined with what reluctance Mr. Tesla would allow his views on this important question to be heralded broadcast to the world, but in doing so he is doubtless actuated by a sense of duty to his fellow inventors, and "simple duty hath no place for fear." Those of us who had the pleasure, a short time ago, of meeting this gentle, unassuming and clever man, can hardly reconcile our views of him as a woman-hater; rather we would interpret this information concerning him as representing him to be not a woman-hater so much as a devotee of science. If he were the former we should feel disposed to remind him that it is very usual for those who have been severe upon marriage in some part or other of their lives, to enter into the Fraternity of Benedicts which they have ridiculed, and to see their raillery return upon their own heads. Marriage, which is a blessing to another man falls upon such an one as a judgment. Congreve's "Old Bachelor" is a literary example of this kind, and Hymen takes his revenge in kind on those who turn his mysteries into ridicule. Mr. Tesla is yet a young man, and doubtless he will be the first to admit that he has much to learn. Possibly his immersion in the deep seas of pure science have so far flooded out from his experience, that emotional life, which, after all, is the only part of life which is worth living. We are not going to take up the cudgels on behalf of matrimony, neither are we going to enlist the resources of our memory in discovering great inventors who caught inspiration and obtained zest for their work, and encouragement to persevere unto the end by associating their lives with women whom they really loved. The history of scientific development is full of such instances, and, if Mr. Tesla is unaware of them, it is only another illustration of the tremendous concentration which he brings to the matters he may have on hand to the entire exclusion of everything else which is interesting in the world. To turn from pathos to bathos, one would have thought that the material advantages, which to many orders of mind is associated with the idea of wife, would have appealed to him when he received, in the course of one of his experiments, a shock of three and a half million volts. It is said that this shock, entering his body above the shoulder, signalised its departure by leaving a hole in his sock. Being a bachelor, it may be presumed that he did not have anyone to mend it, but if he had been of a practically reflective turn of mind, it ought to have occurred to him that matrimony did present some material advantages. Of course Mr. Tesla may be quite invulnerable to Cupid's shafts, but somehow or other we doubt it. We are great admirers of him and his work, and we give him credit for good hard sense, and we do not think he is like the Frenchman who excused his bachelorhood on the grounds that he was "one butterfly zat fly from flower to flower and sip ze honey;" the very fact of his being such a devotee to his science proves that his nature is a very intense one. We have faith enough in women to believe that his fate will come, and that some one will be found who is not only a match for his intensity in all respects, but who will tax his inventive genius to the utmost; for example, in trying to explain where he was at 2 o'clock some night when she had gone to his laboratory to bring him home, and found it dark, although he had told her he was going to "stay down town to work to-night." We are afraid that Mr. Tesla has been studying *Punch*, whose well-known advice about getting married is a household word. Or possibly he may remember Æsop's Fables: the frogs there were extremely wise; they had a mind for some water, but they knew they would have to go down a deep well for it, from which it would be impossible to get out, and so they elected to hop round the edge of the well and contemplate it without committing themselves. Or again, Mr. Tesla may remember that old saying that "he who marries a wife may possibly take an eel by the tail." Whatever may be the cause of the abnormal emotional condition in which this distinguished scientist finds himself, we hope that it will soon be removed, for we are convinced that science in general, and Mr. Tesla in particular, will be all the richer when he gets married.

Some Expert Reports on Electric Traction.

IF the issue of expert reports be reckoned a sign of vitality, we may flatter ourselves that electric traction is in a fair way to make considerable progress during the next twelve months. The voluminous document drawn up by the deputation of the Glasgow Corporation, which covers in a most admirable way the majority of existing systems, has been already referred to. Mr. A. P. Trotter, the Government electrician at the Cape, marks the beginning of his official career by a lengthy report to the Government on the subject of the southern suburbs of Cape Town. But he does more than merely consider the proposed scheme of the tramways company. He traverses the whole field of electric traction, and sets forth in a most lucid manner the advantages and drawbacks of each scheme. It is the overhead wire system with the side trolley that appeals most to Mr. Trotter, and no doubt his opinion is a most valuable one, for he can at any rate claim to have approached the subject with an open mind. The next important report on the subject is one of Mr. John H. Rider, the Borough Electrical Engineer of Plymouth. It is fairly well known that Mr. Rider's scheme combines a traction and a lighting system, the chief feature being the provision of a battery of accumulators in connection with the traction plant. If the scheme is carried out, and we see no reason why it should not be, Plymouth will show the way to achieve some remarkable economies.

Electric Traction Accidents.

SOME days ago an electric tramcar in Columbia, Pennsylvania, left the track and fell down an embankment, five persons being killed, and 40 others injured. That lamentable catastrophe has provided the *Financial Times* with an opportunity to inveigh against electric traction. We have neither the time nor the inclination to correct the ignorant errors that appear in the financial press; but we must point out the obvious absurdity of the conclusions drawn by the writer in the *Financial Times*. It is difficult to conceive why electricity should make a car leave the track any more than steam or animal power. Surely the question is one of speed and construction of the line. It would be as reasonable to argue that because the *Drummond Castle* ran on the rocks, we ought to go back to sailing vessels.

NOTES ON THE INTRODUCTION OF ROPE DRIVING.

The great development of rope driving and its now considerable literature have urged on Mr. Abram Combe, of Belfast, to write a historical account of its origin, lest perchance it should be forgotten that rope driving owed its inception to the Combes, of Falls Foundry, Belfast. This he has presented to the Institution of Mechanical Engineers. He claims that rope driving was originated by Mr. James Combe in 1856, and applied in conjunction with an expanding pulley with V-sides to the differential motion of flax roving frames. It is quite possible that Mr. Combe believes this statement to represent facts, but all the same it does not. The mule spinning frame of Richard Roberts, of Manchester, patented in 1825 and improved in 1830, had the spindles driven by cords, and the rim band is to this day a feature in the spinning mule. Indeed, we believe that a rope was used in the spinning jenny of Hargreaves before Arkwright's time, and Arkwright patented his frame in 1769. We fear that there is no place for Mr. Combe's claim, so far as regards the use of ropes for driving purposes, for their origin dates back probably centuries, and the present writer has seen them on carding engines made before 1850. Mr. Combe, however, applied ropes to much larger powers.

In 1863 he drove 200 H.P. by means of ropes, and he determined by experiment that the groove angle should be about 45°. The ropes were round, and made of leather, but there was a good deal of trouble experienced with them, and Manilla hemp was tried with better results. Mr. Combe's early proportions of pulley to rope diameter were from 28·8 : 1 to 36·0 : 1 for ropes of 1¼ to 2 inches diameter, and the all round ratio of 30 : 1 is the modern ratio and does not differ seriously from Mr. Combe's figures. As regards powers, he fixed on a speed of 100 revolutions as a basis, and allowed 5 I.H.P. for each 1¼-inch rope on a 3 feet pulley, 8 I.H.P. for 1½-inch rope on 4 feet pulley, 11 I.H.P. for 1¾-inch rope on 5 feet pulley, and 15 I.H.P. for a 2-inch rope on a 6 feet pulley. These allowances may be increased 20 to 25 per cent. with safety under best conditions with long distance centres, or equally reduced for less favourable conditions. As regards speed, this was fixed at 3,300 feet, and there is much to recommend this speed on the score of durability; but modern practice seems to be practically compelled to the higher speeds now employed—probably very much because of the minimum pulley diameters desirable on the driven shafts, and the call for these to run at a high rate of revolution which demands a large driver diameter. The danger at present is that high speeds of rope are apt to be thought compulsory.

The author goes on to refer to the possibility of driving between shafts not truly parallel. One drive in 1895 was put up for 100 H.P., the shafts being 3° non-parallel, and this did not require any variation of groove angle. For larger inclinations of shaft angles the grooves require alteration to facilitate the entrance of the ropes without too much side friction. The endless rope system is described as introduced in 1878 for main driving—more especially for shafts at short distances apart. Here again the reduplication system is copied from the mule spinning frame. The reduplication system has found adherents chiefly in America, but has been little adopted for large work in this country.

Mr. Combe describes a system of fly-wheel construction, in which a wrought-iron bolt takes the cotter stress in place of the arm of cast-iron through which it is passed. The danger of pulling off the end of the arm by the cotter in the hub arises from faulty design. A cotter ought not to put a tension on the arm. The extreme end of the arm ought to be turned off true, and so also should the socket in the hub into which the arm is drawn. There need be no difficulty in securing a bottom on to which the arm should be driven hard by the cotter. The same applies to the cottering of piston rods into cross-heads. There should be no tension produced in the rod, merely a compression of the extreme end. At the same time the central bolt is a still better and safer design for wheels. The author describes various drives and rope arrangements, and concludes by stating his belief that ropes do not absorb more power than wheel gearing when properly designed, and anticipates yet further developments in the future.

In opening the discussion Mr. Jeremiah Head gave an example of the general lack of information on rope driving, which is characteristic of so many engineers who ought to know better. It seems late in the day for a speaker at a meeting of the Institution of Mechanical Engineers to call for long splices and proper diameters of pulleys, such as have been used for 20 years. Mr. Arthur Walker would pay a man almost anything to make a first-rate splice in a ⅝th-inch rope. Now, there may be comparatively few splicers of large ropes, but for ropes of ⅝th-inch there is surely no lack of good splicers; he, too, spoke chiefly in platitudes, the one useful item being the fact that he had found 3,300 feet per minute as about the best velocity, having tried as low as 2,000 and as high as 5,000. Mr. Longridge scouted the idea that small ropes were intrinsically more efficient than large, and he spoke to the success of English hemp as a material for ropes.

Mr. McLaren, of Leeds, stated that he had used a ⅞th-inch manilla rope to transmit 40 I.H.P. at 3,500 feet velocity, the rope being 1,600 yards long. It was put round a field for ploughing, and the pulleys were 20 inches diameter and the rope lasted a year. It had to be respliced for each field and by the end of its lifetime had been broken and spliced 24 times a day; an easily understood statement one would think, yet Mr. Combe evidently did not see the gist of it for he went to the trouble of explaining that it would not do in a cotton mill to splice ropes 24 times a day, as though it were not perfectly obvious that a roughly used rope in a field under heavy stresses could not be expected to last like a rope in a sheltered factory. Altogether little useful information was elicited, some speakers being rather solicitous for the enrolment of their fathers names on the scroll of fame as regards ropes.

GAS ENGINE FIGURES AT THE BELFAST STATION.

Some figures of interest were given by Mr. McCowen in his paper read before the Belfast meeting of the Institution of Mechanical Engineers. The charge for current at the Belfast central station is based on a price of 7d. per B.O.T. unit, with discounts of from 2½ to 17½ per cent., the lowest price being 5·77 pence net per unit.

In daylight the charge for power is 4d. per unit, with a discount. The minimum net price to large consumers is 3·3d.

Belfast, as our readers well know, is a gas driven station. The engines are of Dick Kerr and Co.'s make, and there are four Otto cycles in two revolutions, regulation being effected by graduated explosions—not by missed charges. They were originally intended to work at one-third full load by the graduation system, and below that by missing explosions, but the running was not satisfactory, and Mr. Hartley so adjusted the engines that they would run at no load, and yet miss no explosion. This was effected by late gas admission, whereby a small but rich charge was admitted behind a large volume of air, the gas admission being worked by an expanding cam. Some newer engines of high-speed vertical type have been put down by the Acme Gas Engine Company of Glasgow. Each has four cylinders in two tandem lines, with opposite cranks. They are of the closed-in type, with splash chamber. The speed, 380 per minute, means nearly 13 impulses per second, which, with two heavy fly-wheels, gives steady running. An engine of 150 H.P. requires over all a space in plan of 6½ feet × 5 feet, and the combined plant, with 72 kw. dynamo, an area of only 62½ square feet.

In addition to electrical starting, there is a compressed air starting system, the air holder being 4 feet × 12 feet, and the compressor being driven by a 6 H.P. motor. The tests of the No. 6 tandem engine at powers from 19·4 to 92·35 E.H.P., show a gas consumption of 91·7 to 27·4 cubic feet per E.H.P., and of 39·2 to 20·9 per I.H.P. With No. 2 double acting engine at powers of from 8·45 to 41·7, the gas per E.H.P. hour was 64·8 to 29·4, and per I.H.P. hour 24·5 to 21·2. The tandem engines show the best efficiency of E.H.P. to I.H.P., and therefore lower gas consumption per

E.H.P., though, at some powers, higher gas rates per I.H.P. The figures show the rapid increase of cost at reduced load.

The fuel cost is 1·45d. per unit sold, the total cost 5·42d. per unit. The average gas consumed is 53·6 cubic feet per unit sold—46·6 feet per unit generated. The ratio of production to sale is 10 : 9·1. Hence the average gas per E.H.P. power is 34·8 cubic feet. The 9 per cent. of loss is made up of 6·7 in the cells and 2·3 in the mains. In discussing the paper, Professor Goodman, of Leeds, thought the gas consumption was high, especially at light loads, and for such large engines. The engine at the Yorkshire College only used 20 feet of gas per E.H.P., and only 25 feet at half load, but he did not say if the governing was by mixed explosions or by reduced gas. Another speaker also said that even in Belfast he had seen engines of a fourth the size giving one B.H.P. for 18·5 feet of Belfast gas. The high ratio of gas consumption at partial load may, we think, be attributed to the system of governing. As a mechanical arrangement, Mr. Minsteed looked upon the Belfast plant as superior to that at the Yorkshire College, and Mr. McCowen, in replying, added that in Glasgow the Acme engines had given one E.H.P. with a consumption of 22·6 feet. He also added that the rope driving was perfectly satisfactory, and there was no trouble from vibration.

TELEPHONIC COMMUNICATION BETWEEN LIGHT-VESSELS AND THE SHORE.

By CHARLES A. STEVENSON, B.Sc., M.Inst.C.E.

All the numerous and costly trials of connecting lightships with the shore by means of continuous telegraph cables have proved futile, not from the difficulty of establishing connection, but from the impossibility of maintaining it, owing to the ever varying position of a lightship. Even on the most improved system of direct connection on what is known as the swivel system adopted at the *Sunk* and other lightships, the management and life of the connecting cable is a serious difficulty, not to mention the difficulties and expense of moorings.

In America it occurred to Prof. Lucien Blake and Mr. Caldwell to make use of the ship's anchor chain as part of the circuit, and in 1893 this system was tried and was found to work well, the cable being connected to the anchor. Prof. Blake says of this system that it would be the simplest possible for lightships. It is, however, evident that it is defective, in that the cable of the ship would soon chafe and destroy the portion of the armoured cable.

In 1893 Mr. Charles A. Stevenson communicated to the Royal Society of Edinburgh a paper on induction, which contained the results of his experiments in 1892 and a solution of the difficulty, as it showed that it was unnecessary that there should be a continuous electrical cable lying on the bottom. In the summer of 1894* Prof. Blake commenced experiments on the induction method, and on February 23rd, 1895, he made connection with a lightship and proved that the electrostatic system was not only possible, but the subsequent trial of the system in actual operation has shown that it is efficient.

The following description of the installation may be of interest, not that it is perfect in respect of the arrangement adopted for the cables on the sea bottom, but from the fact that electrical communication has been established between a lightship and the shore without any continuous connection. The system consists in having on the ship a bow and stern connection to the sea, and in having a telephone on the circuit between them. In the bottom of the sea is laid an arrangement of cables, such that the whole region within the swing of the lightship is electrified in such a way by the telephone current from the shore as to present differences of potential at different points in the area, sufficient to affect the telephone on the ship. This system of electrostatic induction connection, as well as the electro-magnetic system, were fully described before the Royal Society of Edinburgh in 1893, but as the system has been carried out and has actually been in operation since 1895, a full description of it taken from Prof. Blake's report to the American Lighthouse Board, dated September, 1895, will be interesting probably to the readers of the Electrical Review, in which from time to time there have been valuable contributions on this subject.

The light-vessel is moored in 10½ fathoms of water, and lies 4½ miles off Sandy Hook. Out from the shore an armoured cable was laid terminating in a transformer, the core of the cable being earthed on the armour through the high resistance coil of the transformer, and operated with closed magnetic circuit. The two terminals of the lower resistance coil were earthed in the following manner:—Three insulated copper wires, each about ¼-mile in length, were laid parallel to each other on the sea bottom and 300 feet apart; at one end the three were connected together, and to one end of the terminal of the lower resistance coil of the transformer each of the other ends was earthed by means of pieces of wire netting about 20 feet square, which could be easily rolled up for handling. The other terminal was also earthed by wire netting. The centre of this arrangement is the ship's mooring. There is thus set up in the area round the ship an unequal electrical distribution, such that the electrical potentials are of sufficient difference at the two ends of the ship to operate the telephone on board. The connections on board were as follows:—The two hawse pipes were connected in the hold by a copper bar, and extra plates put between the metallic sheathing and the hawse pipes to secure good sea connection. From the copper bar an insulated wire was carried to a telephone cupboard in the after cabin. When the telephone is not in use a calling device was alone in circuit. The telephones were of the watch form specially wound. Transmitters and receivers were used with induction coils. From the cabin, the cable was carried aft and connected to a tail piece of flexible conductor over the stern. Experiment showed that sufficient difference of potential existed between bow and rudder sheathing, and even between bow and stern sheathing, to operate the receiver, although not as well as between bow and tail ropes.

As it is impossible to operate directly a bell or alarm with telephonic currents, a bell is worked by a local battery, the circuit being closed by a delicate ratchet relay, which although possibly not so delicate as Mr. Stevenson's relay with metallic powder between two electro-magnets, seems to be sufficient for the purpose.

With reference to improvements on the system, Prof. Blake says: "It is evident that in the present Scotland system the submerged transformer is of too small capacity for the most suitable calling device. It is further evident that any increase in efficiency in the telephone system as a whole would greatly lessen the difficulty of calling, and increase the positiveness of talking. Could transmitters converting a greater amount of energy be devised, the talking efficiency would be also correspondingly increased."

The main defect in this system as laid down is that the three wires lie on the area over which the ship swings if moored in the ordinary way. It is, however, quite unnecessary, as has been explained in the Electrical Review, that any cable should lie within the swing of the lightship; and it is to be hoped that if any trials are to be made by the Commission now convened, they should give the two systems of electrostatic and electro-magnetic connection their serious consideration, and that they should employ some one who knows about the subject to carry out the experiments, just as the Lighthouse Board in America obtained the services of Prof. Blake, at least if they wish the subject to be properly investigated, and brought to as successful an issue as the installation in America, and as the importance of the subject demands.

It may be interesting to mention that the lighthouse tender *Gardinia*, was also suitably equipped with transmitting and receiving apparatus in connection with two plates, 7 feet × 3 feet, fixed to bow and stern, a distance of 113 feet apart, and sufficient difference of potential existed between the plates to make the conversation between the shore and the lightship possible while the tender was steaming about in the neighbourhood. Experiments made by Mr. Stevenson, have shown that by the electro-magnetic system, there is no damping effect apparent through an iron hull.

* A long illustrated description of Mr. Blake's apparatus appeared in our issue of September 6th, 1895.—Eds. Elec. Rev.

ANALYSIS OF TRANSFORMER CURVES.

By W. G. RHODES, M.Sc.

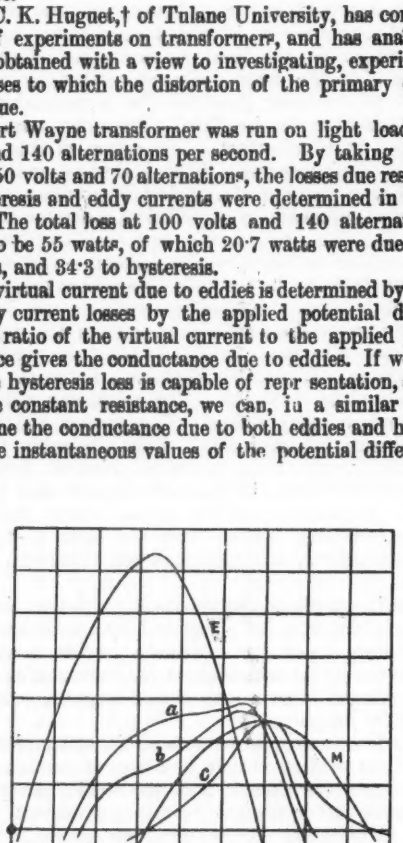
When a transformer is run on open secondary circuit, it is known that the primary current curve is distorted, but that the distortion gradually disappears as the secondary load increases. Most writers have ascribed this distortion to hysteresis. Prof. Rowland,* however, has demonstrated mathematically that the effect of hysteresis can be of the nature of resistance, and that the distortion of the current curve might be due simply to the superposition of higher harmonics, caused by variations in the permeability of the iron core.

Mr. C. K. Huguet,† of Tulane University, has conducted a series of experiments on transformers, and has analysed the curves obtained with a view to investigating, experimentally, the causes to which the distortion of the primary circuit is really due.

A Fort Wayne transformer was run on light load at 100 volts and 140 alternations per second. By taking a second run at 50 volts and 70 alternations, the losses due respectively to hysteresis and eddy currents were determined in the usual way. The total loss at 100 volts and 140 alternations was found to be 55 watts, of which 20·7 watts were due to eddy currents, and 34·3 to hysteresis.

The virtual current due to eddies is determined by dividing the eddy current losses by the applied potential difference, and the ratio of the virtual current to the applied potential difference gives the conductance due to eddies. If we suppose that the hysteresis loss is capable of representation, as due to a simple constant resistance, we can, in a similar manner, determine the conductance due to both eddies and hysteresis.

If the instantaneous values of the potential difference are



multiplied by the conductance due to eddies, and the resulting eddy current curve subtracted from the total primary current curve, the remainder is the curve which would be derived from the hysteresis loop. If, similarly, the instantaneous values of the potential difference are multiplied by the conductance due to both eddies and hysteresis, and the resulting current curve subtracted from the total primary current curve, the remainder will be a true wattless current curve.

In the accompanying figure, E is the potential difference curve, M the induction curve, *a* the total primary current curve, *b* the difference between *a* and the eddy current curve, and *c* the difference between *a* and the combined eddy and hysteresis current curve.

The important point to notice here is that the curve, *c*, is nearly symmetrical with respect to the induction curve, M, and this is found to be the case, no matter how distorted the original current curve, *a*, may be. The peaked nature of this wattless current curve, showing the presence of odd higher harmonics, is therefore due to variations in the permeability of the iron core, for the peak is symmetrical with respect to the induction curve, and hysteresis is essentially unsymmetrical with respect to it.

When a transformer is run on open secondary circuit, the power component of the current is but small, so that the peaked wattless component has an appreciable effect in distorting the total current curve. When, however, the secondary is loaded, the power component of the primary current is great compared with the wattless component, so that there is but little distortion of the total current curve.

Let $b = B_0 \sin p t$ and $e = E_0 \cos p t$ (1)

represent the induction and primary potential difference respectively. These equations are justified by the fact that on open secondary the primary current is very small, so that the impressed potential difference very nearly equals the back E.M.F.

Eliminating t, we get

$$\frac{b^2}{B_0^2} + \frac{e^2}{E_0^2} = 1. \qquad (2)$$

Mr. Huguet calls the curve connecting hysteretic current and the induction a *hysteretic characteristic*. It is a curve drawn with half-widths of the hysteresis loop as abscissæ, and the corresponding inductions as ordinates.

If we suppose that hysteresis is capable of representation by a simple resistance, r, then the hysteretic energy current, x, is given by the equation,

$$x = \frac{e}{r}, \qquad (3)$$

and the equation to the hysteretic characteristic is, by substitution in (2),

$$\frac{b^2}{B_0^2} + \frac{x^2 r^2}{E_0^2} = 1, \qquad (4)$$

which is the equation to an ellipse.

Conversely, if the hysteretic characteristic is (a quadrant of) an ellipse, hysteresis is capable of accurate representation by a simple resistance, that is, the effects of hysteresis would be exactly the same as those of a simple resistance. In this case, therefore, the distorting harmonics in the primary current curve are due solely to changes in the permeability of the iron core.

For low induction densities such as are used in practice in transformers, it is found that the effect of hysteresis in distorting the primary current is *nil*, or at any rate, negligible.

It appears, therefore, that for *sine* applied potential differences, Prof. Rowland's hypothesis may be taken to be correct for such moderate induction densities as are used in transformer cores.

GAS ENGINES AS ECONOMICAL MOTORS.

In a paper read before the Gas Institute, Mr. Halliday presents some useful figures of costs as between gas and steam power. The advantage to electrical engineers of the success of all gas undertakings is obvious. Gas managers, when intelligent, perceive that electricity has been the best friend the gas works ever had, and electricity now receives considerably less abuse than formerly. Mr. Halliday points out one of the weak points in electrical works driving. Thus, he says, if your works require 1,000 horse-power, you must have, first, boilers of 1,000 H.P.; then, an engine of 1,000 H.P. to drive a 1,000 H.P. dynamo to transmit current to motors of 1,000 H.P. There is thus room for doubt as to the economy of transmitting electrical power over small areas as of a works, or ship-yard. Of course, the economy comes in the very much smaller power really required when electricity is generated at a central point, and transmitted to the point of user, and there used in place of the power being wasted in shaft friction. But much of this economy, with economy of plant, may be secured by the use of gas engines, the gas being conveyed without loss or friction, and very short lengths of shafting being needed. Gas ought easily to show itself cheaper than steam in such cases, but we think Mr. Halliday hardly appreciates that the saving by electricity is due to the enormous reduction in the losses. He might have said that where steam of 1,000 H.P. is needed in a scattered works, there would be needed for electricity 250 H.P. of motors, 200 H.P. of generators, 180 H.P. of engines and of boilers.

* Rowland. "Notes on the Theory of the Transformer." *Philosophical Magazine*, Vol. xxxiv., p. 54.

† Huguet. "An Analysis of Transformer Curves." *Transactions*, Inst. Am. Elec. Eng., June, 1896.

For working warehouse hoists, Mr. Parry, of Liverpool, states that steam, gas, and compressed air, cost per I.H.P. hour 0·810d., 0·425d., and 0·700d., gas being charged at 2s. 10d. per 1,000, and gas power has been very largely introduced of late years for dock and bonded stores work. In Scarborough, the gas used for power purposes amounts to 2½ per cent. of the total gas output, and is used in 55 engines of a total of 155 horse-power at an average annual cost per horse-power year of 10·11d. The length of the year in hours is not given, but the gas consumption per horse-power per year is nearly 368 feet, so that the year cannot very well be over 18 hours if the engines were fully loaded, which is hardly likely to have been the case, and we may take it that the engines were not above half-loaded. Mr. Halliday considers that electric light may be generated privately by means of gas power for 18 per cent. less than its cost from public mains; we presume he has reference to Scarborough prices.

At Barmen, an industrial town in Rhenish Prussia, with gas at 3s. 4d. per 1,000 cubic feet, and coal at 12s. 6d. per ton, small gas powers are shown by Herr C. Korte to cost less than steam up to powers of two horse, and with coal at 20s., gas is the cheaper up to 4 H.P.

In a private electric light installation, figures supplied to Mr. Halliday show for a year's working as follows:—The units (B.O.T.) consumed varied from 122 in June to 2,412 in December; the total H.P. from 161·8 in June to 3,220·3 in December, the gas used from 7,100 in June to 95,400 in November; the maximum gas consumption not exactly coinciding with the maximum number of units generated. The gas used per H.P. varied from 39·5 feet in June to 28·5 in December, and the cost per unit for wages and gas varied between 5·40d. in June down to 1·53d. in December.

In the months of May, June, and July, the average cost per unit was just under 4½d. In the other eight months the unit cost only averaged 2½d., which is considerably less than the regulation 6d. per unit of the supply companies. We suppose there is no accumulator in this installation, or the gas used per H.P. would not be so much greater in June.

It would appear that a Board of Trade unit can be produced for about 40 cubic feet of gas, or for about 1½ with gas at 3s. to 3s. 4d. In a small private house, with gas engine and accumulators, attendance is *nil*, and electricity need not exceed 1½d. for current expenses. We recently inspected such an installation where the engine was a small vertical Crossley in the back scullery of a semi-detached house. The starting was a matter of a few seconds only, and once installed, there was no wages cost. Our friend, however, was a good amateur mechanic, and had made his own dynamo, so that he was not compelled to have much outlay in repairs. Still it shows what can be done, and it is surprising that there is not a greater amount of private lighting done by house property owners, who could so readily and cheaply supply both light and water, and effect economies of often several hundred per cent.

THE SEAT OF ELECTRO-DYNAMIC FORCE.

Messrs. Houston and Kennelly have been experimenting with a view to establishing the true seat of electro-dynamic force in electromotors. For this purpose they constructed an experimental motor, in which the holes in which the winding was embedded near the periphery of the armature were sufficiently elongated to allow of the winding being moved while the core was fixed, and the core to be moved when the winding was a fixture.

They formed a cage of 10 bars between two discs coupled up as a drum armature, 10 amperes being passed through the bars in series while the field was separately excited.

Fixing the field, the torque on the winding was found to be 5·4 gr. cms.; fixing the winding, the torque was found on the iron core to be 336·5 gr. cms., thus proving apparently that the pull on a toothed armature or hole-wound armature comes altogether on the iron core. Now, it is well known that the pull on an armature with a smooth core is exerted on the winding, and the authors of the experiments conclude that the action of the two classes of armatures are radically different, that the magnetic forces act on the teeth of the armature and not on the wires or bars. But the experiments and their results are quite in accordance with the well grounded notions held on electro-dynamic forces.

While it is usual to speak of the cutting of lines of force by conductors setting up E.M.F., referring to smooth cored armatures, such language conveniently represents the action in the air gap, but the cutting of lines of force by the conductors is not so obvious in transformers, nor is it easily grasped as an idea in toothed and hole-wound armatures, hence another theory is that the E.M.F. is set up by the variation of the number of lines of force enclosed by the winding. Both theories give the same results, for the rate of cutting lines by the conductors is necessarily equal to the rate of variation of the number of lines in the coils or winding, but all experience goes to prove that only during the time of an increasing or decreasing magnetic flux through a coil does an E.M.F. appear, and, moreover, it is well known that a coil carrying a current experiences a torque or force only when in a position to move so as to enclose more or less lines. If the current is in one direction the coil moves or pulls to enclose more lines; if the current is in the other or opposite direction, the coil moves or pulls so as to enclose fewer lines, the lines being the same in both cases. That is the simple theory of all electromotors.

In continuous current motors, a coil or conductor carrying a current can move and rotate without having any core of iron, but no iron core can rotate without carrying a current on it or in it.

Now, in this experiment, the windings in the armature can be moved slightly in their holes, but their motion in such a position can neither increase nor decrease the lines enclosed by the winding, hence there is no torque felt upon them. On the other hand, the core is magnetised by the armature currents, and then the field-magnet lines of force are distorted through the air gap and teeth, causing the torque on the iron core; the lines are stretched out of their direct course by the magnetic effect of armature current, so that each projecting tooth is pulled or pushed.

With a smooth armature the same distortion occurs, but the distorted lines pass through the copper or other winding, hence the force is exerted there only; for the core being smooth there is no path easier for entry of lines than another.

It seems, then, that we shall require to modify the theory of armature actions; the electro-dynamic force may act at different points apart from the conductor carrying the current. In the smooth cored armature the current carrying conductor is in the distorted field of force, and is, therefore, the seat of the electro-dynamic force itself. In the toothed armature the teeth are in the distorted field, hence they become the seat of the impelling forces.

In an electromotor we have two cardinal effects, torque and counter electromotive force, and the important indications of the Houston-Kennelly experiment seems to be that the torque is due to the local distortion of the field at each conductor on a smooth armature, and at each tooth on an ironclad armature, while the back E.M.F. is due in both cases to the variation in the rate of enclosing lines of force by the winding.

Such experiments are of great value; they enable us to picture the actions and reactions of current carrying conductors and magnets with a nearer approach to truth. It must never be forgotten that lines of force, cutting them or enclosing them, are mere theories; what the actual interactions between currents and magnets are we know nothing of as yet.

The knowledge that the electro-dynamic force acts on the iron core if it projects between the conductors, will no doubt lead to some developments in motors and dynamos, both alternating and continuous. It has been suggested that the experiments confirm the rotary polar theory of the induction polyphase motor; it cannot help out that theory, for it matters not whether the force of torque acts on the iron or on the conductors. The current in the armature conductor and the magnetic force in the field are the factors which in both cases produce the torque, and that is true in all motors, polyphase included; the rotary pole theory is a delusion and a snare, and can only be a hindrance to progress.

The toothed armature and hole-wound armature would seem from these results to have considerable advantages; from a mechanical point of view it is better to have the force acting on the iron core than upon the conductors.

LIGHTING CIRCUITS FOR ELECTRO-THERAPEUTIC REQUIREMENTS.

A UNIVERSAL TRANSFORMER FOR ALTERNATING CURRENT.

In the course of an article that appeared recently,* we read what are at present the processes that enable us to utilise most advantageously the *continuous* current of the lighting systems for the requirements of electrotherapeutics. In this case it is the electric *accumulator* that furnishes the *transformer* required to vary at will the voltage or the intensity for the various applications, with perfect safety to the operator and the patient.

We now propose to describe a new apparatus which answers a similar purpose in cases where it is required to utilise the alternating current of lighting circuits, or at any rate in the most frequent cases.

The alternating current at 110 volts may be utilised in electro-therapeutics for five principal purposes :—

1. As a motive power for the driving of static machines, vibrators, or even small continuous or sinusoidal current dynamos.

The power of these motors should be capable of attaining to from 10 to 13 kgm.

With regard to this point, we will merely say that it is at present very difficult to obtain industrially good alternating current motors. In fact, it is only much more powerful motors that are constructed in an industrial way; as to those constructed specially for the purpose in question, or for working ventilators, they are, as a rule, very defective. We have had in our hands motors said to be of 8 kgm., from which it was impossible to get more than from 3 to 4 kgm.

2. For the production of vibrations of high frequency. We shall have occasion to return to this question presently; moreover, the apparatus required for this transformation cannot be utilised for any other purpose. At the most we can only combine special ozonisers with high frequency.

3. For thermic galvano-cautery, the current serving as a source of heat.

4. For the special electric lighting required for the examination of the eyes, the throat, or cavities such as the bladder;

5. For the mode of electrification adopted by Dr. d'Arsonval, under the name of the sinusoidal current, when we are limited to the frequency of the machines of the central station :

The transformer known as the "universal," which we have had occasion to study with M. Gaiffe, serves to effect the transformations of current required for these last three applications; moreover, it enables indoor and outdoor lighting and galvano-cautery to be effected simultaneously, which is a great practical advantage, as the operator has only one apparatus to regulate.

Before describing this apparatus, we will briefly examine the conditions that have to be fulfilled for these three operations, and also the methods that have been adopted up to the present, and their defects.

Galvano-cautery.—As we have already said in relation to the continuous current, we require, for cauteries, a maximum of 8 volts, and a current capable of attaining, in certain cases, to 40 amperes; the regulation should be very exact in order to enable incandescence to be attained, at which cauterising can best be performed. If we employ *directly* the current of the lighting circuit (which may be conveyed either through a local transformer or through the transformer of a sub-station), regulating it by a rheostat,† we are exposed to the disadvantages mentioned in our former article : waste of current, expensive and cumbersome apparatus, and, lastly, risk.

This risk may arise either from the patient not being properly insulated, in which case the application of the cautery will cause a shock, or from the breaking of the cautery, in which case the 110 volts of the circuit will act upon the tissues. This solution of the question is, therefore, quite *inadmissible*. The substitution of a reaction bobbin for the rheostat, although advantageous as regards the *apparatus*, in no way remedies the want of safety.

A somewhat better method, and one which was proposed and adopted recently by certain makers, consists in using a *transformer* to reduce the voltage to the limit required, for instance, 8 volts; the volts are then regulated at the terminals of the cautery, and the current by a rheostat or a reaction coil.

The inconveniences resulting from the imperfect insulation of the patient are in this case entirely avoided, since we have to do with a local circuit. On the other hand, we have always to fear lest on the accidental breaking of the cautery the patient should receive the maximum available voltage or 8 volts; now, it is known by personal experience, that this is the limit of what can be borne when the resistance of the epidermis is suppressed. Lastly, and this is an important point, a transformer only gives a constant voltage at the secondary terminals if all the parts are calculated with perfect accuracy. This is, perhaps, more than can be expected as a rule from medical instrument makers. Thus, under these conditions, we should often get an apparatus in which at the moment the secondary circuit was opened, the voltage would attain to two or three times its original value. Such a system, which would be only of mediocre value with a good apparatus, would be positively dangerous with one that was at all defective.

Medical Lamps.—The little lamps used for internal or external examination vary very greatly in their voltage from 2 to 16 volts, for example, with a current of 2 amperes at its maximum; we know, in fact, that we cannot make very small lamps with high voltages as a suitable filament could not be obtained. These lamps must be capable of being brought to the exact point of incandescence.

As in this particular case, the question of safety is not involved, a rheostat reducing the 110 volts of the circuit to the required voltage would, if necessary, suffice; the employment of a special transformer giving the maximum required would scarcely be justified, since a rheostat with several keys would still be necessary for the different lamps.

Sinusoidal Current.—The medical applications of alternating currents with a regular variation (a practical translation of the term sinusoidal), require a maximum of 30 volts with extremely low currents, a few milliamperes at the most. Only in the case of hydro-electric baths are 100 milliamperes reached.

The currents should be capable of being regulated continuously, and the open circuit voltage must not be much greater than the difference of potential when the circuit is closed; otherwise one would be exposed to disagreeable shocks when the contact at the electrodes is not perfect. Some carefully designed chariot transformers constitute a good solution of this problem. We must avoid adding to them in series a reaction coil, which would too greatly modify the form of the current.*

The Universal Transformer.—The new universal transformer brought out by the firm of Gaiffe and Cie., with multiple secondary circuits and continuous regulation, meets these various requirements, it allows of the simultaneous regulation of an examination lamp of from 0 to 16 volts, and of a cautery requiring 8 volts and 20 amperes, or 40 or 50 amperes with less voltage. The independence of the two secondary circuits is complete, *i.e.*, the opening of one of the circuits, even with a considerable current, does not practically modify the current in the other circuit; lastly, for cauterising, we always employ only the minimum E.M.F. required. Upon the breaking of a cautery that is working at 2 volts, we shall only have 2 volts at the electrodes within 10 to 15 per cent.

A third secondary circuit, constituted by the union of the two first, enables us to obtain the 24 volts required for the sinusoidal currents.

The apparatus may be applied as well in the consulting room as at the hospital, or at a patient's house which is lighted by the alternating current, we have only to connect the primary to a lamp socket by a derived current. In fact, this apparatus is equivalent to three transformers,

* *L'Electricien*, No. 279, May 2nd, 1896.

† In all cases in which cautery is effected under 110 volts, the circuit cannot be broken on account of the arc; short-circuiting must be resorted to. This entails a fresh inconvenience; we can easily leave the circuit closed.

* See *L'Electricien*, No. 201, November 3rd, 1894.

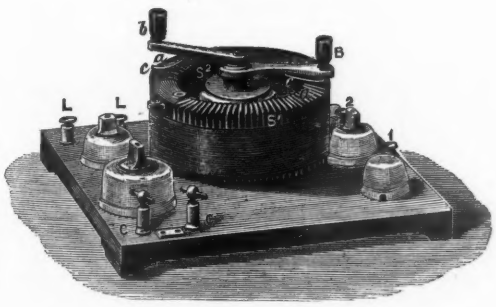
the secondary circuits of which might be made to vary spiral by spiral. For this two secondary circuits have been grouped, with very different wires on the same iron core, provided with a suitable primary circuit, and the mode of regulation used in continuous rheostats has been applied, in which a handle introduces the wires, spiral by spiral, into the circuit.

The accompanying figure gives an idea of the outward appearance of the apparatus which was exhibited for the first time at the Exhibition of the Société Internationale des Electriciens last May.

The iron core, in the form of a circular ring, consists of discs of sheet iron. The primary circuit is wound directly upon it in the usual manner, and connected with the terminals, 1, 2, by fusible wires and an interrupter.

The secondary circuit is composed of two distinct parts. One of these circuits, of very thick wire, s_1, has such a number of turns, that the voltage in open circuit shall be, say, 8 volts, and each spiral makes this voltage vary about ·2 volt.

The first secondary circuit or cautery circuit is wound on one part only of the core, about half of it. On the upper part, at *a*, the wire is bare, and the handle, B, with the spring, *c*, which is connected with the second terminal, C, of the cautery circuit, enables 1, 2, &c., spirals to be taken successively between the terminals, C and C, *i.e.*, the voltage can be graduated according to the cautery used, so that in every case it may be brought to the temperature required.



On the remainder of the core is wound a second circuit, s_2, in much finer wire, and with a greater number of turns, so as to have, for instance, 16 volts between the extremities of this wire, the beginning of which is connected with the last spiral of thick wire and the end with one terminal, L. The other terminal, L, of this lighting circuit is connected with the second handle, *b*, provided with the rubber, *c*, which also comes in contact with the bare part of the wires, s_2, which are raised to the same height as the wires, s_1. On this second circuit can be obtained voltages varying from 0 to 16 volts for the various lamps employed, and these can be brought by insensible degrees to the required degree of incandescence. Lastly, by connecting with the terminals, L and L, and by progressively moving the little handle, *b*, we can graduate the volts insensibly from 0 to 24 volts (in the example chosen), which enables the sinusoidal voltaïlisation to be effected in all cases. A stop limits the course of the cautery handle, B, to the thick wire only, or there would be a risk of burning the secondary fine wire. The apparatus is completed by two interrupters, enabling the cautery circuit and the lighting circuit to be broken independently of one another.

We may briefly refer to the great economy of the system, although the question of consumption of current is a secondary one in medical operations; thus a cautery of 30 amperes, requiring 6 volts, would only entail an expenditure of about 2·5 amperes in the primary circuit, or about 2·7 watt-hours.

If the primary circuit were accidentally disregarded, no serious consequences would result, for the current when free is only ·19 amperes.

We have said that the reaction of the two circuits was insignificant; it has, in fact, been found that under very unfavourable conditions—say the sudden suppression of 20 amperes in the complete cautery circuit (160 watts)—the voltage in the lighting circuit would only vary from to 14 volts, or about 7 per cent., which would involve no danger to the lamps, even if over-run.

The following little table shows within what limits the cautery circuit is regulated :—

Primary current.	Secondary current.	Volts at the terminal.
·19	0	8·2
·78	7·5	7·5
1·34	15	7·2
1·86	20	6 8
2·50	30	6 0

The reader who is acquainted with transformers, may ask what will happen when one of the handles puts a spiral on short circuit. In the case of the thick wire, theory shows that the current on short circuit might attain to about 400 amperes; the heating produced by this current would be inadmissible, but it is found that the resistance of the contact is such compared to that of a spiral, that the current is reduced to about 60 amperes. The heating corresponding to this is perfectly admissible; the inductive reaction of this current on the opening or closing of the short circuit by the handle produces only a scarcely perceptible variation of the current in the utilisation circuits.

In conclusion, we may remark to those readers that are specially interested in industrial questions, that an apparatus of the same kind may be of use for the standardising of amperemeters, if it is completed by a suitable rheostat. This is why we have felt called upon to give the description of an apparatus intended for a special purpose.

Moreover, we think that it is quite as well for those engaged in installations to be acquainted with the special conditions of working of the electrical apparatus used for medical purposes.— E. Meylan (*Revue Internationale de l'Electricité*).

CORRESPONDENCE.

The Improved Electric Glow Lamp.

In the full and interesting particulars of the improved electric glow lamps, given in this week's Review, it appears to me that one thing has been omitted from Mr. Grindle's report which would go far towards proving the contention of the lamp company that their lamp is a great improvement on anything in the market.

I refer to a trial of the lamp against other lamps silvered in a similar manner, or a trial of their lamp unsilvered would very easily have given the actual candle-power and efficiency as against lamps of different manufacture.

As you point out, the silvering of lamps is a very old process, and it is absurd to try lamps under the unequal conditions shown in this case, and placing the results before the public as affording any guide to the real merits of the trial.

The Ediswan lamp, which was chosen as a standard, could easily have been obtained silvered in the same manner as the "Improved" lamp, and I should await with interest a fresh report by Mr. Grindle under the conditions herein suggested.

Subscriber.

[The suggestions made by our correspondent were alluded to in our article.—Eds. Elec. Rev.]

[Pressure upon our space compels us to hold over until next week a communication on "Alternate Current Rushes in Condensers," by A. F. Berry.—Eds. Elec. Rev.]

Société des Ingénieurs de France.—The annual prize of this Society has been awarded to M. J. Euverte for his memoir relative to "The Metallurgy of Steel and Iron at the Universal Exhibitions of 1889 at Paris, and of 1894 at Lyons." The Couvreux prize has been awarded to M. A. de Bovet for his memoir on "The Mechanical Traction of Boats; Electro-mechanical Haulage." The Giffard prize has been awarded to M. L. Goichot for his memoir on "The Transmission of Motive Power by Means of Electricity for the Exploitation of a houille (?) mine." The Giffard prize consists of a medal and of 3,000 francs.

ELECTRIC AND MAGNETIC RESEARCH AT LOW TEMPERATURES.

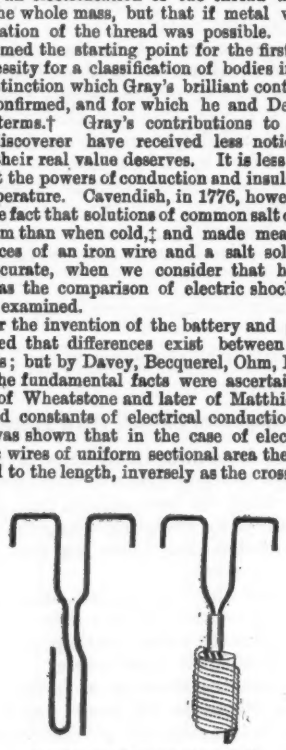
By Professor J. A. Fleming, M.A., D.Sc., F.R.S., *M.R.I.*, Royal Institution of Great Britain—Weekly Evening Meeting, Friday, June 5th, 1896.

The Right Hon. Lord Kelvin, D.C.L., LL.D., F.R.S., Vice-President, in the chair.

During the last four years much time has been spent by Professor Dewar and by me in the prosecution of a joint research on the principal electric and magnetic properties of metals at very low temperatures. Some reference has already been made in previous discourses by Professor Dewar to portions of this work,* but the special object of the present lecture is to extend these descriptions, and put you in possession of the latest results in this department of the low temperature investigations. It will be convenient to discuss the several divisions of it in the order in which they have engaged our attention.

One hundred and sixty seven years ago Stephen Gray, a pensioner of the Charterhouse, in conjunction with his friend Granvile Wheler, stretched a packthread 300 feet long over silk supports, and demonstrated that an electrification of the thread at one end spread instantly over the whole mass, but that if metal wires replaced the silk no electrification of the thread was possible. This experiment undoubtedly formed the starting point for the first definite recognition of the necessity for a classification of bodies into insulators and conductors, a distinction which Gray's brilliant contemporary, Dufay, extended and confirmed, and for which he and Desaguiliers coined these familiar terms.† Gray's contributions to knowledge as an epoch-making discoverer have received less notice from scientific historians than their real value deserves. It is less easy to state who first noticed that the powers of conduction and insulation were greatly affected by temperature. Cavendish, in 1776, however, was perfectly familiar with the fact that solutions of common salt conduct electricity better when warm than when cold,‡ and made measurements of the relative resistances of an iron wire and a salt solution which were marvellously accurate, when we consider that his only means of measurement was the comparison of electric shocks taken through the bodies to be examined.

Not until after the invention of the battery and galvanometer was it clearly proved that differences exist between the conducting powers of metals; but by Davey, Becquerel, Ohm, Pouillet, Fechner, and others all the fundamental facts were ascertained, and the classical researches of Wheatstone and later of Matthiessen, gave us the accurate laws and constants of electrical conduction. By these investigations it was shown that in the case of electrical conduction through metallic wires of uniform sectional area their total resistance was proportional to the length, inversely as the cross section, and also



Low temperature resistance coil.

Fig. 1.

proportional to a specific constant for each material called its *resistivity*. Moreover, it was found that this resistivity was considerably affected by temperature, generally being increased in metals by rise of temperature, and decreased for carbon, electrolytic liquids and many badly conducting bodies.

Although much knowledge of the behaviour of pure metals and alloys in regard to electric conduction has thus been accumulated, we considered that it would be of great scientific interest to examine with care the changes occurring in the conductivity of these bodies, or reciprocally in their resistivity, when cooled to temperatures of two hundred degrees or more below the Centigrade zero by the aid of liquid oxygen and liquid air.§ Knowing the great influence of very small quantities of impurity on this quality, our first attention was directed to obtaining samples of alloys and metals in a state of great chemical purity, in giving to wires drawn from them a suitable form, and in devising a convenient support or holder by which the electrical resistance of the wire might be measured when immersed in liquid oxygen or liquid air, either in quiet ebullition in an open vessel, or under reduced pressure in a closed one. It will be unnecessary to dwell on the difficulties surrounding the preparation of these accurately drawn metallic wires of pure metal. Suffice it to say that our obligations to Mr. George Matthey, Mr. Edward Matthey, Mr. J. W. Swan, and other friends were very great with respect to this portion of the work. The final outcome of all failures was the production of a resistance coil of the following form:—Two thick wires of high conductivity copper about 3 or 4 mm. thick are bent as shown in fig. 1, and wrapped round the lower part with a cylindrical sheath of thin vulcanised fibre laced to them by a silk thread. On this sheath, which generally had the form of an oval cylinder, a paraffined silk cord was spirally wound so as to leave a helical groove. In this groove was coiled the resistance wire, of known length and section, and its ends were attached by solder to the ends of the thick copper leads. The wire was wound a little loosely in the groove so as to allow for the great contraction which takes place in cooling, and yet the wire was exposed so as to take up instantly the temperature of the bath, whilst at the same time the mass of material to be cooled down was rendered as small as possible. The length of wire employed was generally about 1 or 2 metres, and the diameter from about one-twelfth to half a millimetre (·003 inch to ·02 inch). These mean diameters were measured by the microscope micrometer at about 50 to 100 places for each metre length of the wire. Having thus prepared a great collection of resistance coils of pure metals and alloys, each in the form of a wire of known length and mean diameter, the next operation was the measurement of their resistance at definite temperatures. For the sake of those not fully familiar

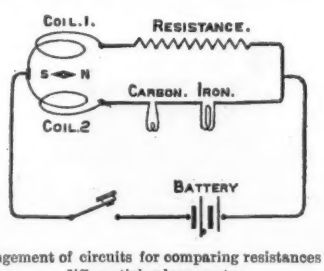


Diagram of arrangement of circuits for comparing resistances by means of the differential galvanometer.

Fig. 2.

with the details of electrical measurement, a moment's digression may be made to explain two of the principal methods in use. Becquerel's work was chiefly conducted with the differential galvanometer. In this instrument two coils of wire of exactly equal length are coiled on one bobbin, in the centre of which hangs a small magnetic needle. The current from a battery (see fig. 2) divides at one point, and flows along one path through the conductor or conductors under examination and through one coil (No. 2) of the galvanometer. The other portion of the current flows through a wire of variable length called a rheostat, and through the other coil of the galvanometer, equal in every respect to the first coil, but circulates round the needle, N.S., in an opposite direction to that of the current in the first coil. Hence, if the currents are of equal strength, the needle is not disturbed at all from its zero position. We can make these currents equal by adjusting the length of the wire of the rheostat so that its resistance is equal to the resistance of the coil being tested. By this means it is easy to verify all the ordinary laws of conduction. We can, for instance, show at once that by cooling an iron wire in iced water its resistance is decreased, whereas in cooling the carbon filament of a glow lamp its resistance is increased.

This method is not generally so convenient as the arrangement first described by Mr. Hunter Christie to the Royal Society in 1833, re-devised 10 years later by Wheatstone in 1843, and which has been always curiously misnamed the "Wheatstone's bridge," even in spite of Wheatstone's own declaration that he did not invent it.* In this arrangement (see fig. 3) the current from a battery, B, has two paths open to it by which to complete its circuit, and we employ a galvanometer with a single coil to discover two points on these two circuits which are at equal potentials. When these two points are connected the galvanometer needle is undisturbed, and it is a simple matter to show that under these circumstances the numerical values of the electrical resistances of the two segments, A X, X D, of the circuit, A D, denoted by P and Q, and the resistances, R and S, which form the other branch, are to one another in simple proportion as R is to S—that is, P is to Q as R is to S. In actual work, one form, useful for lecture purposes, which this arrangement takes, is that known as the slide wire bridge (see fig. 4), and which is before you. In this construction the battery current flows partly through a uniform wire, *a b*, stretched over a scale, and partly through a standard resistance, R′, and the resistance, R, to be tested placed in series with it.

We employ a galvanometer, G, to connect the middle point between

* "Scientific Uses of Liquid Air." A Friday Evening Discourse by Professor J. Dewar, LL.D., F.R.S., delivered at the Royal Institution, January 19th, 1894.

† See the "Intellectual Rise in Electricity," by Park Benjamin. Stephen Gray's papers on this subject, communicated to the Royal Society, are as follows:—*Phil. Trans.* 1720, Vol. xxxi., p. 104; 1731, Vol. xxxvii., p. 18; 1732, Vol. xxxvii., p. 285; 1735, Vol. xxxix., p. 16; 1736, Vol. xxxix., p. 400. See also Dufay, *Phil. Trans.* 1733, No. 431, p. 258.

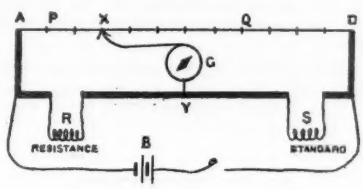
‡ See the "Electrical Researches of Cavendish." Edited by Clerk-Maxwell, p. 324.

§ Almost the only experimental work previously done in this subject seems to have been that of Cailletet and Bouty (*Journal de Physique* July, 1885), on the "Resistance of Metals at − 100° C.," using ethylene as a refrigerating agent; and a research by Wroblewski, on the "Resistance of Copper at very Low Temperatures" (*Comptes Rendus*, 1885, Vol. ci., p. 161).

* See *Phil. Trans.*, 1833, Mr. S. Hunter Christie, on the "Experimental Determination of the Laws of Magneto-Electric Induction." See also Wheatstone's Scientific Papers, p. 129, "An Account of several new instruments for determining the Constant of a Voltaic Circuit," *Phil. Trans.*, Vol. cxxxiii., p. 303, 1843.

R and R′ with some point on the slide wire, and we can always find a point on the slide wire such that no current flows through the galvanometer. The ratio of the unknown resistance, R, is to that of the known standard resistance, R′, in the ratio of the lengths of the two sections into which the contact piece divides the slide wire. Hence R is determined in terms of R′. Another form of this appliance in which all three arms of the bridge consist of coils of wire capable of being joined, as required, in series with each other by plugs, is most commonly used, and it was a most carefully adjusted Elliott bridge of this last pattern which we employed.

All our resistance measurements have been reduced to express them in terms of the International ohm, as defined by the Board of Trade Committee, and obtained by reference to standard coils carefully standardised for us at Cambridge. By this means the whole of our wires were measured at five definite temperatures, viz., at about 200° C.; at the temperature of boiling water, 100° C.; at the temperature of melting ice, 0° C.; at the temperature of solid carbonic acid melting in ether, which gives a temperature of about − 78° C.; and at the temperature of liquid oxygen boiling under a pressure of 760 mm., which gives a temperature of − 182° C.

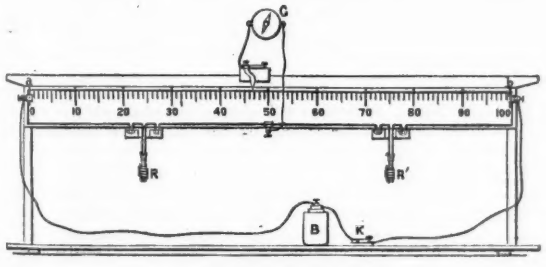


Wheatstone's bridge arrangement for comparing resistances.

Fig. 3.

In this last case the coils were immersed in liquid oxygen contained in suitable vacuum-jacketed vessels. In this connection, I should like to express with due emphasis the opinion that none of this low temperature research would have been possible at all without the assistance of Prof. Dewar's most valuable invention, the glass vacuum-jacketed silvered vessel. For much of this work it has been necessary to employ many litres of liquid oxygen and air at a time, and to be able to keep it for hours in a state of perfect quiescence and absolutely constant temperature, and in no way could this have been done without this beautiful and scientific device.

Before describing the results of these experiments, it may be interesting to exhibit a few of the principal facts. The most striking of them is the very great reduction in electrical resistance, or increase in conductivity, experienced by all the pure metals when



Slide wire bridge. Lecture form.

Fig. 4.

cooled in liquid air. Here, for instance, are two coils of iron wire: balancing them on the bridge we find them to be of exactly equal resistance, but if one of the coils is cooled in liquid air, its resistance is reduced to about one-tenth of its resistance at the ordinary temperature of the air. We may also compare the resistances of these two similar iron coils, when one is placed in boiling liquid air and the other in boiling water. The resistances, instead of being in the ratio of one to one, are now in the ratio of one to twelve. Again, if we take two wires, one of pure iron and one of pure copper, of exactly equal length and equal section, we find that at ordinary temperatures (15° C.) the iron wire has about six times the resistance of the copper; but if we cool down the iron wire in liquid air to − 186° C., still keeping the copper coil at the ordinary temperature (15° C.), we now find that the iron coil has actually become a much better conductor (about 30 per cent. better) than the copper.* On the other hand, if we examine the behaviour of this coil of German silver, which is a copper-zinc-nickel alloy, or of this platinum-silver coil, we find that the cooling down through 200° has a comparatively small effect upon its electrical resistance. We thus see that whilst pure metals have their electrical resistance immensely decreased by cooling to the temperature of liquid air, alloys generally do not experience anything like so great a change.

(*To be continued.*)

* The exact resistances of the coils used for the experiment were as follows:—Iron at 16° C. = 7·003 ohms, and reduces to 0·711 ohms; at − 186° C. copper at 16° = 1·169 ohms, reduces to 0·2033 at − 186° C.

LEGAL.

Clark *v.* Julius Sax & Co., Limited.

In the Chancery Division of the High Court of Justice on Friday, the 7th inst., Mr. Justice North had before him, in this case, a motion on behalf of the plaintiff that all further proceedings in the action might be stayed, and the defendants ordered to pay to the plaintiff the costs of the action.

Mr. Swinfen Eady, Q.C., on behalf of the plaintiff, explaining how the motion came to be made, said that the plaintiff, John Clark, claimed to be the registered proprietor of a design for a lamp that was adapted for electric lighting, and was used in the Central Meat Market. On February 8th last the plaintiff moved for an interim injunction to restrain the defendants from infringing his registered copyright in the design, and on the same day Julius Sax & Co., Limited, moved to take the plaintiff's mark off the register. His Lordship dismissed both motions, holding that the design was a good registration, but that there was no infringement. The defendants then proceeded to construct a lamp which was almost identical with the plaintiff's registered design, and the plaintiff issued a further writ on February 18th, and on March 13th his Lordship granted an injunction until trial, restraining the defendants from infringing the registered design in respect of the new infringement. On April 3rd there was judgment in the Queen's Bench Division in an action between the same parties. There was an agreement between the parties, under which the defendants were to take all their lamps for the electric lighting of the Meat Market from the plaintiff, who bound himself to sell to the defendants all the lamps required for the purpose. The plaintiff complained that the defendants obtained lamps elsewhere, and sued them for damages. That action came before Mr. Justice Mathew, who gave judgment for the plaintiff for £142 damages, and the defendants undertook not to put up in the Market any electric lamps not supplied by the plaintiff. On May 11th the Court of Appeal, on appeal from his Lordship's order as to the registration, directed the registration to be expunged; but, of course, that did not affect the Queen's Bench action, because whether the plaintiff's registration was good or bad, the agreement between the parties still stood. On June 29th the defendants issued a summons that an inquiry might be directed as to what damages they had sustained by reason of the order of March 13th, which the plaintiff ought to pay, and that except so far as might be necessary for the purpose of the inquiry, this action might be dismissed with costs, for want of prosecution. In the result, the chief clerk adjourned the summons into court, to come on with the defendant's motion to stay proceedings. He (Mr. Swinfen Eady) submitted that it was not a case in which there ought to be an inquiry as to damages, and that the defendants should pay the costs.

Mr. Vernon Smith, on behalf of the defendants, submitted that it was a matter of course for the Court to direct an inquiry, because the defendants had been caused expense by having to pull down the lamps, the plaintiff of course being safeguarded by the costs of the inquiry being reserved. As regarded the costs of the action, he submitted that as the defendant's summons to dismiss the action for want of prosecution was before the plaintiff's motion, the defendant was entitled to his costs.

Mr. Justice North made one order on both motions, staying proceedings in the action, and gave no costs to either side.

The Farringdon Works, Limited, *v.* I.E.S. Accumulator Company.

An action was heard before Mr. Roxburgh, in the Lord Mayor's Court, on Tuesday, in which the plaintiffs sued for balance of account for two tons of oxide of lead. The defendants had paid £12 6s. 3d., leaving a balance of £22 19s. 9d. It was alleged by the defendants that the stuff was useless, and owing to its being deficient they were entitled to recover back the £12 6s. 3d. paid, and they counterclaimed for damages caused to 1,600 accumulator plates by using the stuff, the damage being laid at 6d. per plate.

Mr. Crisp appeared for the plaintiffs, and Mr. Scott for the defendants.

The works' manager of Messrs. Walker Parker said they had supplied oxide of lead to the defendant company direct, which had been prepared in accordance with instructions, and they had also supplied it through the plaintiffs. He remembered executing an order for the 2 tons in question, and there was no difference between it and the previous supplies.

Other witnesses were called to show that there was no material difference in the oxides supplied at various times.

Mr. Thomas Digby, the manager of the I.E.S. Accumulator Company, gave evidence to the effect that the oxide of lead, after it had been applied to the lead plates, fell off. A workman in the employ of the Accumulator Company gave evidence as to how the oxide of lead was applied to the plates. After hearing further evidence, the jury returned a verdict for the plaintiffs on the claim and counterclaim, and judgment was entered accordingly.

Jandus Arc Lamp.—We understand that a 2-ampere Jandus arc lamp has been designed to meet the requirements of shop keepers and others, who desire a small lamp which will burn about 100 hours, and give a white and perfectly diffused light inside their shop windows. Messrs. Drake & Gorham have lamps ready to be seen at any time.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Aug. 11th, 1895	£	s.
Adelaide Teleg. mtl. ...	45	0
Amsterdam	140	0
Bilbao	65	0
Bombay	70	0
Brisbane	150	0
Brussels	42	0
Calcutta	142	0
Candia Teleg. mtl. ...	83	0
Cape Town	181	0
East London	439	0
Hamburg	25	0
Hong-Kong Telephone	34	0
Mariopol	415	0
Melbourne	100	0
,, Teleg. mtl.	154	0
Montreal	14	0
St. Petersburg. Teleg. mtl.	46	0
Shanghai	772	0
Sydney	21	0
Tientsin	75	0
Wellington	39	0
Yokohama	6,086	0
Total	£9,138	0

Week Ending Aug. 11th, 1896.	£	s.
Adelaide	43	0
Alexandria	79	0
Amsterdam	285	0
Bangkok	24	6
Brussels	84	0
Buenos Ayres	494	0
Calcutta Teleph. mtl. ...	14	0
Cape Town	107	0
Colombo...	195	0
Delagoa Bay	21	0
Durban	273	0
East London	1,281	0
Flushing	20	0
Gothenberg. Teleg. cable	276	0
Laurenço-Marques Tel. ml.	25	0
Madras. Teleph mtl. ...	18	0
Malta.	50	0
Melbourne	20	0
New York	1,000	0
Port Elizabeth	19	0
Rangoon	33	0
Shanghai	32	0
Singapore	34	0
S'ockholm	144	0
Sydney	660	0
Westport	177	0
Yokohama	63	0
,, Sub. cable ...	3,545	0
Total...	£9,016	

Foreign Goods Transhipped.

	£	s.		£	s.
Hamburg	25	0	Sydney	145	0
			Venice	80	0

Agency.—Messrs. A. & W. Hopkins, of Parliament Street, are acting as agents for Pearson's automatic fire and other indicators. They supply indicators and alarms for a large variety of purposes, such as for private houses, for ships' holds, powder magazines, incubators, testing laboratories, &c.

Catalogue.—Electrical goods, such as bells, bell pushes, door contacts, alarms, galvanometers, wires, batteries and general electrical sundries, as manufactured and sold by Messrs. Howard B. Little & Co., of Shaftesbury Avenue, are particularised and illustrated in a list just published by them. The firm makes a speciality of electro-medical apparatus, and this is dealt with in several pages.

Change of Address.—Messrs. Davies, Kent & Stewart have removed their offices and works to 19 and 21, Heddon Street, Regent Street, London, W.

Dissolution of Partnership.—Messrs. A. E. Slade Templeton & W. H. Merriman, who have hitherto traded at 15, New Broad Street, as telegraph construction engineers, dealers in electrical materials, &c., under the style of Slade Templeton & Co., have dissolved partnership. All debts will be attended to by W. H. Merriman, at 15, New Broad Street, where, from July 24th, A. E. Slade Templeton will carry on the business on his own account.

Liquidation Notices.—At meetings of the Val D'Aosta Electric Power Company, held at 32, Victoria Street, on July 7th and 22nd, it was resolved to wind the company up voluntarily.

Ediswan Lamps.—Of lamp catalogues there is no end in these days, but one naturally turns to that of the original makers—the Edison and Swan United Company—for the most exhaustive particulars of incandescent electric lamps. The list just issued by that company is a most complete collection of many varieties of electric lamp, and in addition to this, is interesting because of the general information relating to the marking of lamps, lamp efficiencies, duration, also low candle-power and high voltage lamps. A table covering two pages shows the approximate currents of lamps at various voltages, candle-powers, and efficiencies. There is abundance of good illustrations of terminals, but the art of the engraver, as also the care of the printer, show up to best advantage in the blocks of lamps, particularly the crinkled, festooned, and cut glass. Section 2 of the catalogue gives the lamps in seven classes, *i.e.*, standard, high voltage, series, sunlight (high C.P.), focus, special, and extra special. For all lamps the C.P., limit of voltage and price are given very clearly. Quite a number of tubular, festoon, and fairy lamps are detailed, also conical and spirola shapes. There are lamps with double filaments, twisted loop lamps, train lighting lamps, "Bi-life" lamps, and lamps coloured and variegated. For further particulars we must refer our readers to the original.

Electricity in Mining.—The general manager of the Robinson Deep Mine, in his June report, says: "During July I should advise the commencement of work on foundations for new hoisting plant at No. 2 shaft, electric plant, compressor plant," &c.

Engine List.—Lists of horizontal cross compound engines and high speed vertical electric lighting engines, as manufactured by Messrs. Clench & Co., of Lincoln Works, Chesterfield, are before us.

Fowler-Waring Cables Company.—The National Telephone Company have just placed a contract to the value of nearly £100,000 for dry core telephone cables with the Fowler-Waring Cables Company, Limited. The company's factory at North Woolwich has recently been equipped with a most complete plant for the manufacture of rubber and allied substances, and for the insulation of rubber-covered wires and cables. These, together with every description of mechanical rubber goods, will now be added to the manufactures of the company. Mr. Alfred E. Mavor, who has been general manager since the formation of the company, becomes technical director; Mr. J. A. Blackwood will succeed to the secretaryship of the company in place of Mr. B. J. Diplock, who is resigning the position.

Outing.—On Tuesday, the 4th inst., the combined staffs of the Electrical Company, Limited, and the Calmon Asbestos and Rubber Works, held their third annual outing. The neighbourhood chosen this year was Boxhill, and the weather was all that could be desired for a coach drive through the lovely Surrey scenery. After a substantial luncheon served at the Burford Bridge Hotel, athletic competitions were improvised on the top of Boxhill itself, and were followed by a ramble and an excellent tea. A surprise presentation was made to the managing director, Mr. F. T. Eggers, by the employés of the two companies, consisting of a handsome gold chronometer watch.

Pocket Catalogue.—A new edition (the sixth) has been issued by the Chloride Electrical Storage Syndicate Limited, of their handy pocket price list and catalogue. The list is dated July, 1896, and is just the thing for easy reference.

ELECTRIC LIGHTING NOTES.

Ayr.—Mr. Pink, burgh electrical engineer, recently reported that the cost of laying a service main from Seafield to the South Lodge would not exceed £100. Subject to the clerk's obtaining a guarantee from Mr. Coats, Belleisle House, to take the electric light supply for at least five years, with a minimum consumption equal to £100 per annum, the Council authorised the cable to be laid.

The contract for the lighting of Wellington Chambers, Ayr, with 200 glow lamps has been placed with the Tayler Smith Electric Company.

Bangor.—An account rendered by Mr. Medhurst for £100 for professional services in connection with the electric lighting proposal, has been ordered to be paid. Notices have been received from two companies who proposed to apply for provisional orders, but the Council itself has already made application.

Bath.—At a special meeting of the Bath Electric Light Company, held on Friday last, the formal contract for the purchase of the works by the City Corporation was approved and signed. The actual taking over of the works will follow the Local Government Board inquiry.

Belfast.—The Electric Committee has been considering the desirability of adding to the generating plant at the central station, and has given directions on the subject to the electrical engineer.

Bexhill.—A London electric lighting company has asked whether the Council intends applying for a provisional order, and the communication has been referred to the Lighting Committee.

Blackburn.—The Council is to make application for a £15,000 loan for electric lighting purposes.

Bradford.—With a view to encouraging the use of electricity for motive power purposes and increasing the day load, the Corporation Electric Lighting Sub-Committee has determined to reduce the charge from 3½d. to 2½d. per unit. This proposition has yet to go before another committee and the corporation, as also has a recommendation to lay two additional cables in Horton Lane and in Church Bank and Barkerend Road.

China.—It is reported that a company has lately been formed at Sutschau, a newly-opened port to the south-west of Shanghai, to erect and operate a central electric lighting station.

Darwen.—We understand that Mr. E. M. Lacey, C.E., has been commissioned by the Town Council to report upon a scheme for electric lighting.

Derby.—The Local Government Board has sanctioned the borrowing of £11,134 for electric lighting purposes. Sowter's Road has been lighted with incandescent electric lights, and the cost per lamp has been ascertained to be £4 12s. 9d. per annum.

Devizes.—At a quarterly meeting of the Corporation on 7th inst., it was resolved, on the recommendation of the Committee, to appoint a sub-committee, to consider the question of electric lighting.

Dorking.—The District Council has resolved to apply for a provisional order, being of opinion that the powers should be in its own hands.

Dover.—This week being Dover Cricket Week, the town has been gaily and somewhat elaborately decorated, the Sea Front being illuminated nightly by means of festoons of over 1,000 32-C.P. incandescent lamps.

Dundee.—In a note regarding the progress of the electric lighting undertaking since its inauguration in March, 1893, the *Dundee Advertiser* says that the fears entertained by many that the gas and electric lighting undertakings being in the same hands would interfere with one another have turned out to be groundless, and the two concerns are now developing along independent lines. The following figures show the position:—

March, 1893 ...	40 customers	1,990	8-C.P. lamps.
December, 1893 ...	... ...	8,470	" "
December, 1894 ...	... ...	11,860	" "
December, 1895 ...	About 270 customers...	16,016	" "

In certain thoroughfares where it was least thought the light would be needed, mains have since had to be laid. Arc lamps are largely used by shopkeepers for exterior lighting.

The Gas Committee recommends the Council to appoint Mr. Tittensor as electrical engineer at £200 per annum. The mains are to be extended down a number of thoroughfares at a cost of £1,047. Tenders for the necessary cables are to be invited.

Frankfort.—At the end of March last the municipal central station at Frankfort-on-Maine was supplying current to an equivalent of 32,811 16-C.P. lamps, and 71 electric motors of 642 H.P.

Fulham.—At the last Vestry meeting the Electric Lighting Committee reported recommending the expenditure of £75, to enable a deputation of the Vestry to visit the provinces and report as to the working of electric lighting and dust destructors. After a discussion, in which personalities were indulged in to some extent, the recommendation was rejected by 18 to 13 votes. The County of London and Brush Provincial Company gave notice that they intended to apply for a provisional order, but the Vestry intends opposing the application.

Gateshead.—A private firm having expressed the intention to apply for powers to supply Gateshead with electricity, the Parliamentary Committee had thought it their duty to see if the municipality could not work the electric light supply themselves. However, as the firm had withdrawn, the committee thought it would be better to wait for about a year or so before embarking on an expenditure of £30,000 or £40,000. Perhaps another company may come along and interrupt the Council in its long sleep.

Glasgow.—The Sub-Committee on Electric Lighting recently reported, with reference to the resolution to experiment with eight of the arc lamps at the west end of Sauchiehall Street, that they had approved of a design by Messrs. Macfarlane & Co. of an arm and pendant projecting three feet only from the pillar, which will admit of the lamp being made a fixture. It was also agreed that it be remitted to a committee, with power to obtain alternative estimates for 8 or 100 of the new design of arm and pendant now adopted, and to accept either of the estimates.

Glasgow.—St. Andrew's Hall is to be lighted by electricity at an estimated cost of £1,647. The sub-Committee on Halls has been granted full powers for accepting tenders and carrying out the work.

Godalming.—The details of the electric lighting scheme have been arranged by a special committee, and last week the Council pledged itself to apply for a provisional order and carry out same.

Hampstead.—The ratepayers in the High Road, Kilburn, are again petitioning the Vestry for consideration to be paid to the lighting of the road. They want electric arc lamps fixed before the dark evenings come on. The matter is in the hands of a committee.

Hastings.—The Council has resolved not to allow the Hastings and St. Leonard's Electric Light Company to construct a transformer pit under the pavement at Clarement, at a point suggested by them. They have therefore disapproved of the plans.

Hull.—The Insurance Company has notified the Electric Lighting Committee that the premium for the insurance of the electric lighting works will be increased from 2s. per cent. to 10s. 6d. per cent. It is under consideration whether the Corporation cannot insure the property itself. We wish them success in their deliberations, and shall not be surprised to hear that many other Corporations are doing likewise.

India.—The magazines and arsenals in Fort William, Calcutta, are to be lighted by electricity, and the work of laying down the plant is being proceeded with.

Islington.—At the last Vestry meeting, in answer to Mr. Mills, the treasurer (Mr. Towers) said it had not yet been exactly ascertained what were the receipts and expenditure with reference to the lighting of the parish by electricity.

Lambeth.—The exact terms of the agreement between the Vestry and Mr. Sax in connection with the electric lighting have now been settled and passed by the Vestry.

Leamington.—After further considering the estimate of the Midland Electric Lighting Company for lighting the Parade with arc lamps, the Town Council has resolved to defer the matter for the present, and in the meanwhile the cost of improved gas lighting is to be ascertained.

London.—It is stated that during the forthcoming recess a serious effort will be made by the Office of Works to complete the scheme of electric light installation at the Houses of Parliament.

The St. James's Vestry has decided to pay the St. James's and Pall Mall Electric Light Company £30 per lamp per annum for street lighting for a period of seven years. The company suggested a period of 21 years.

Larne.—The Lighting Committee has made a tour of the town, and recommends the erection of 16 C.P. lamps at various points and 25 C.P. at others, if matters can be satisfactorily arranged with the electric light company.

Manchester.—We understand that a further reduction has been made in the price of electricity to large consumers, equal to about 25 per cent.

Morecambe.—The District Council has decided to apply to the Board of Trade for their consent to the purchase by, and transfer to the Council, of the powers and property of the Morecambe Electric Light and Power Company, in accordance with the terms of an agreement dated February 10th, 1896.

Plymouth.—Mr. E. G. Okell, of Bowdon, has been selected from among four candidates for the post of assistant electrical engineer to the Corporation. The Corporation has adopted the scheme of the electrical engineer, to which we refer elsewhere, for electric lighting and power installation, and has decided to apply to the Local Government Board for power to borrow £45,000 for that purpose.

Railway Train Lighting.—The directors of the Highland Railway have agreed to introduce, by way of experiment, the electric light in their through carriages between Perth and Inverness.

Sheffield.—The Cutlers' Hall is to be lighted by electricity.

Sunderland.—Six of the applicants for the post of borough electrical engineer have been asked to interview the Committee.

Taunton.—The electrical engineer (Mr. Couzens) reported at the last Council meeting that there had been a very satisfactory increase in the lamp connections in the borough, 92 lamps of 16 candle-power having been installed, and a further 84 applied for.

Tonbridge.—A Committee has been appointed by the District Council to consider the question of adopting the electric light for street and private lighting. Failing the Council taking the matter up, there is a prospect of a local company doing so.

Walsall.—The Council cannot see its way to extend the street electric lighting to Digbeth and High Street, because it would cost at least £100 per annum more than gas.

Wells.—The surveyor has been directed to confer with Dr. Hopkinson regarding the electric lighting scheme.

York.—A fair notion of the public feeling at York regarding electric lighting will have been gathered from the brief notices which have appeared in these columns from time to time. The opposition has seemed to be extending, and we should not be very surprised if the powers for lighting this ancient city pass to a company. At the present moment, however, there is a point in connection with these matters to which we must draw attention. The Lord Mayor of York, we imagine, is a shareholder in the York United Gas Light Company, at least we gather so from the fact that at the meeting of this company, held on 6th inst., he moved a vote of thanks to the chairman. We do not for a moment question his *right* to say what he likes as a shareholder of the company, but we certainly think that he being Lord Mayor would have shown better taste by avoiding reference to the question of electric lighting upon such an occasion. He, however, seems to have allowed his enthusiasm for gas to come before the observance of municipal etiquette. Anyhow, if pecuniarily interested in gas, it would be illegal for him to exercise even a casting vote in the Council. The following is an extract from his remarks, as reported in the *Yorkshire Herald*:—"The members of the Corporation had to face the question of the introduction of the electric light into the city. He believed that the report of the committee would have to be read during the year, and the feeling which he knew existed in the city on the subject should be respected by the Corporation. It was to the effect that the citizens were thoroughly satisfied with the gas at its present price—and that they did not wish to have the luxury of the electric light at the cost of the ratepayers. He did not think it was possible to have a system that would pay for the first few years, and he thought it unfair that the citizens should be taxed for the luxury. He hoped that the Corporation would seriously consider the matter before they parted with their powers to an electric lighting company, and go to the Local Government Board and ask for an extension of time before they were compelled to adopt the scheme. He felt that the Board would grant them an extension of five years. He did not despise the electric light, and thought that it might exist side by side with gas. There was a large field for both, and if it came to York he did not believe that the gas company would be materially affected."

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Algeria.—Work is about to be commenced on the construction of several lines of electric tramway on the Thomson-Houston overhead conductor system in the town of Algiers. The plan at the central power station will comprise three steam dynamos of 200 kilowatts capacity each.

Bolton.—The Town Council last week passed a resolution to secure Parliamentary powers for working the local and suburban tramways, and using electricity as the motive power.

Bristol.—On Bank Holiday the electric tramways were well patronised. Twenty-four electric cars—in twelve pairs each, consisting of motor car and trailer—carried 30,417 passengers, as against 27,746, with the same number of cars on Whit Monday, thus showing an increase of 2,671.

Electric Swing Bridges.—The River Weaver trustees are arranging for improvements to the waterway. These alterations include two swing bridges, which will probably be worked by electricity.

Glasgow Corporation Tramways.—When the first wave of municipal enthusiasm in the direction of tramway management began to spread over such cities as Glasgow and Leeds—not to speak of London—it required very little foresight to point out that the difficulties in the way of progress in mechanical traction methods would be by no means reduced, but rather increased thereby to a considerable amount. This follows from the fact that with ordinary limited companies—such as have hitherto owned and operated tramway systems—there is practically only a small group of shareholders, governed by more or less autocratic directors, with which one has to reckon in any proposal for improvement in traction. But a Tramways Committee in a large Municipal Council is not only composed, as a rule, of men far more difficult to deal with than the average director, its constituents also have to be considered: and the god Demos is desperately fickle, unstable in all its ways, and sadly in need of a strong guiding hand. It must be allowed that both Glasgow and Leeds are to be congratulated on the possession of Tramway Committees filled with energy and enterprise; and in this respect they are fortunately placed. The general body of ratepayers, however (with the feeling that each individual one has a 6d. stake in the matter), shows a very strong inclination to interfere where ignorance should rather draw back, and this inclination, as a rule, is greatly fostered by the local newspapers of a socialistic tendency. The time for definite action in such a manner has hardly yet arrived so far as London is concerned, nor will it do so until the County Council has obtained full possession of the various lines; and the same remarks apply to Manchester, Liverpool, and many other important cities; but the acute stage of "ratepayers' fever" as regards mechanical traction and improved transit generally has now been reached in Glasgow, and will probably continue for some months. Leeds has had a pretty mild attack, though there may yet be a recurrence when extensions of the new trolley line now in progress are talked about and decided upon. With regard to Glasgow, however, the ratepayers are clamouring loudly because the Tramways Committee has, in their opinion, moved a little too fast; wishing, indeed, to introduce electric traction with overhead wires on one of the routes as an immediate experiment—*before public opinion has been sufficiently educated to the idea!* No terms of disapprobation can well be too strong for this outcry, even granting the wisdom of a "hasten slowly" method. The Committee, it is true, was not unanimous last week in adopting the proposal (only carried, indeed, by the casting vote of the convener); but this indecision had reference rather to the particular route to be converted than to the choice of overhead wires. For the outside public and non-technical newspapers to raise a clamour against trolley wires, and gravely discuss the advantages for the Glasgow tramways of gas motor cars (whose qualities, duly set forth in a company prospectus, are taken for granted by one of the Glasgow papers as being absolutely reliable), would be too ridiculous for notice, if it were not that the elected members of the local authority must perforce act in some measure as their constituents' representatives to carry out their mandates: and have done so. It shows, at any rate, a great want of trust in the members of sub-committees who have been deputed to examine the problem of mechanical traction, and who—at first prejudiced against overhead wires—have returned, from learning something about the matter, with every possible confidence in the trolley wire method as the best and cheapest. Doubtless there is no particular harm in withdrawing, for a time, the proposal decided upon last week by the Glasgow Tramways Committee, provided that the interval is spent by those who wish to postpone the matter in learning all they can about the subject in a fair and unprejudiced way; and so far, therefore, the Committee's action in postponement may be approved. It is, however, greatly to be hoped, that when once a unanimous decision has been come to by the Committee, the whole Council will approve of the matter, irrespective of Tom, Dick, or Harry, and their various opinions, and allow the speedy equipment of at least one section of the Corporation tramways for electric traction, if only to serve as an object lesson to the "dear public." Otherwise the position of the latter will inevitably remind one of the old Greek "akolastikos," setting forth the incident of a man who went in for bathing and nearly got drowned, his first act on restoration being to register a vow that he wouldn't go into the water again until he could swim. The good Glasgow people are standing shivering on the brink of an invigorating bath, and seem afraid to make the plunge. Being admittedly rather more of an authority on the subject of electric traction than the average councillor, we hasten to assure those who interest themselves in the matter up North, that they will have to wait a long time before they secure any better system of rapid transit than that afforded by overhead wires on the latest principles, such as are employed at Bristol and Leeds—on the new lines.

The Horseless Carriage Bill.—In the House of Lords, on Monday, the Commons' amendments to the Locomotives on Highways Bill were considered and agreed to.

New York to Philadelphia.—It is stated that a syndicate of Philadelphia capitalists has acquired from the original owners, by purchase for cash, the New York and Philadelphia Traction Company and the Central Jersey Traction Company, for the purpose of making it one of the most important electrical enterprises in the States, the idea being to connect New York and Philadelphia by a direct route of electric railroad. Contracts are understood to have been let for portions of the work. The syndicate is headed by Mr. J. P. Gandy, a man of considerable means, who is largely interested in electric railways in the States.

Printing by Electricity.—The Linotype machines used in setting up the type, and the machine for printing the *South Wales Daily Post*, at Swansea, are now driven by means of electric motors, current being supplied from the works of Messrs. J. C. Howell & Co.

Sheffield.—A Tramways Traction Sub-committee has been formed to visit certain towns, and advise what system of traction shall be adopted.

Sunderland.—The Sunderland Tramway Company are considering the advisability of adopting electric traction throughout their system, and Mr. Reginald P. Wilson, of 3, Prince's Mansions, is preparing a report on the subject. The expenses per car mile at Sunderland, horses being employed, for the year ending December 31st, 1895, are 8·15d., the percentage of expenses to receipts being 61·93.

The Latest Car Fender.—The latest thing invented in the States in fenders for tramways is an excellent arrangement for clearing the track. It consists of a row of rollers arranged shear-plough fashion across the track in front of the truck. These are held up away from the track normally, but when an object strikes the rake in front they are dropped to the ground, and the victim is rolled to one side by the rollers. Whatever remains of the victim—that is what the pavement does not scrape off during the brushing aside operation—can then be taken charge of by the company's surgeon.—*Street Railway Review.*

The Light Railways Bill.—In the House of Lords, on Monday evening, the Light Railways Bill was considered in Committee. Several amendments were discussed, and the Bill passed through committee.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (1869, Anglo)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Monte Alegre-Santarem ...	May 5th, 1896 ...	...
Bissao-Bolama	May 30th, 1896 ...	August 6th, 1896.
Gibraltar-Tangier	July 28th, 1896 ...	August 12th, 1896.
Para-Maranhao	Aug. 6th, 1896 ...	...
Landlines.		
Trans-Continental line beyond Mazol (Mashonaland)	March 12th, 1896 ...	...
Communication with Cartagena and Barranquilla, Columbia.	July 4th, 1896 ...	...
Salisbury-Umtali (cutting off communication with Beira)	July 10th, 1896 ...	...
Moulmein-Bangkok	July 28th, 1896 ...	August 7th, 1896.
Saigon-Bangkok	Aug. 10th, 1896 ...	August 11th, 1896
Siberian lines, Radde-Khabarowska	Aug. 5th, 1896 ...	...
Khabarowska-Vladivostock...	Aug. 12th, 1896. ...	...

African Trans-Continental Telegraph.—A Salisbury despatch, dated August 11th, says that Captain McCallum, constructor of the African Trans-Continental Telegraph Company, was murdered by Mashonas at Matetima on June 25th. There was no provocation of the natives, and the only conceivable motive for the cowardly attack was the sight of the large stores. The camp was looted after the captain's death. This affair will not seriously check the telegraph work, but it will have a bad effect on the other "boys." As the officials in charge of the line are unarmed, a request has been made for 20 mounted police to protect the work of construction.

Telegraph Material for Turkey.—The Turkish Administration of Posts and Telegraphs is about to give us some contracts for the material required for several new telegraph lines, a credit having just been voted to the department for the purpose.

(*Continued on page* 209.)

THE GENEVA EXHIBITION.

In a country in which water-power is everywhere available, and coal is an entirely foreign product, it is not surprising that electricity should have rapidly attained a large development. We find it forming one of the most important features of the Geneva Exhibition.

To begin with, a small electric tramway starting from the main entrance conveys the visitor round the grounds. The construction of this tramway placed the contractor in presence of a serious dilemma. A trolley line had been forbidden by the directors of the Exhibition, while the expense of a conduit system was prohibitive in the case of a temporary installation. The problem has been solved in a primitive, though, as it appears from the working of the line, fairly satisfactory manner. The rails themselves, each one supplemented by a bare copper wire laid alongside of it, serve respectively as positive and negative mains. No insulation is provided beyond the ordinary sleepers. The top of the rail being flush with the surrounding roadway, the leakage current sometimes rises as high as 30, and even 50 amperes, though the pressure is not more than 100 volts. In Geneva, however, where power may be had for next to nothing, and where a Board of Trade is unknown, this is not regarded as any great drawback.

The same company (Cie de l'Industrie Electrique) also exhibit a very interesting set of constant current generators intended for the transmission of power to the Chaur de Fonds. The system adopted is similar to that employed at Genoa, and lately at the Val de Travers, but the voltage in the present instance will attain to 14,400 volts, the current being kept constant at 150 amperes. The drop in the line at full load will not exceed 4·6 per cent., or 675 volts. All the motors placed in series will be supported on porcelain insulators, themselves bearing on a flooring composed of asphalte, sand, and other materials, and said to be in itself a very good insulator.

We hope subsequently to give a full account of this remarkable application of the Thury system.

The generating station of Chèvres, near Geneva, is represented by a full-size model of the alternators and turbines employed there. Each alternator can give at full power 1,100 to 1,200 H.P., the maximum output of the station being 12,000 H.P.

We may also note a large continuous current dynamo ordered by a British company from the Oerlikon Works (Zurich). It is destined to be used in the manufacture of aluminium. The output is 7,500 amperes at 65 volts. This generator will be direct-coupled to a turbine running at 150 revolutions a minute. The Oerlikon Works also exhibit a number of three-phase and single-phase motors driving various machine tools, cranes, &c.

The firms of Alioth, of Bale, and the Société Suisse, of Neuhausen, are also represented.

Geneva Exhibition Machinery Hall

MECKENBEUREN-TETTNANG ELECTRIC RAILWAY, WÜRTENBERG, GERMANY.

This installation, although a small one, possesses many features of interest. It is the first main line railway which has been equipped on the trolley system in Europe, and the success attending the installation is quite remarkable. The central station, besides furnishing power for the tramway, also supplies power for lighting and runs several stationary motors.

The line was opened on December 4th, 1895, and its great success from the beginning proves beyond doubt that for branch railways electricity is the ideal motive power.

The track is standard gauge, and there are 26 trains daily going over the line. The installation was designed by Mr. O. von Miller, and the work was carried out by the Maschinenfabrik Oerlikon.

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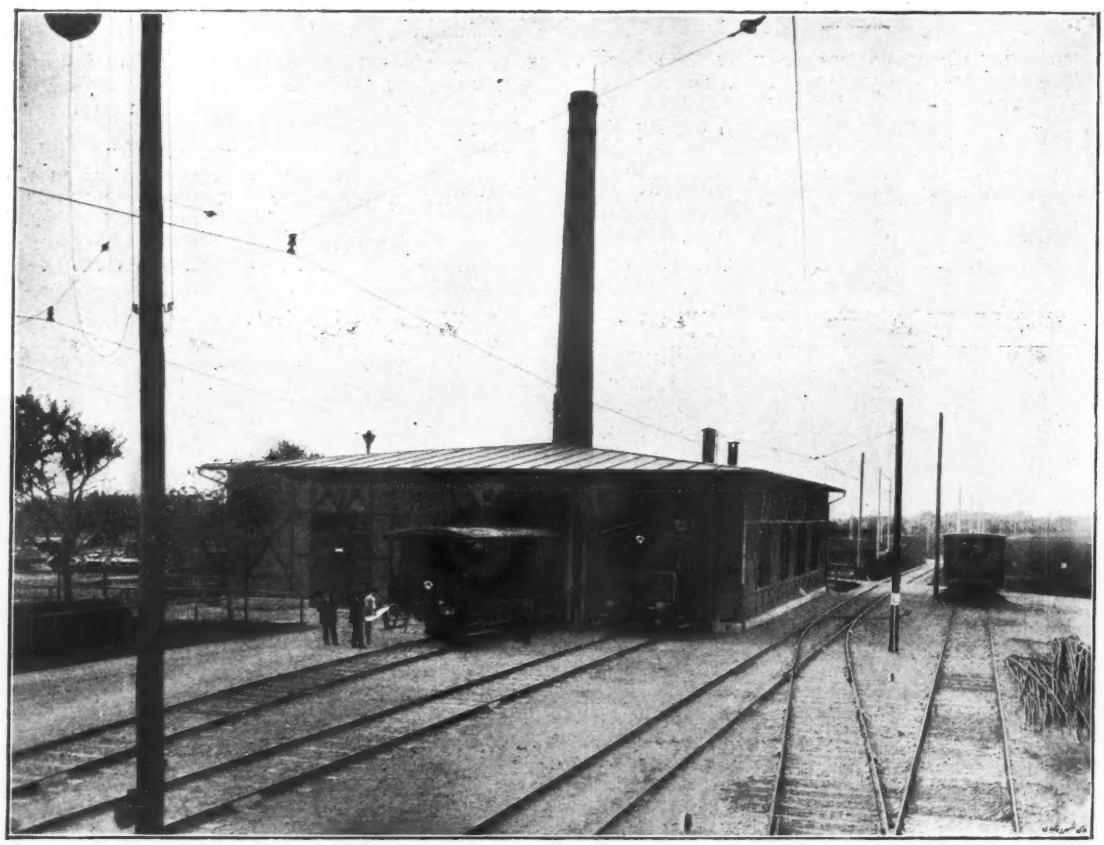
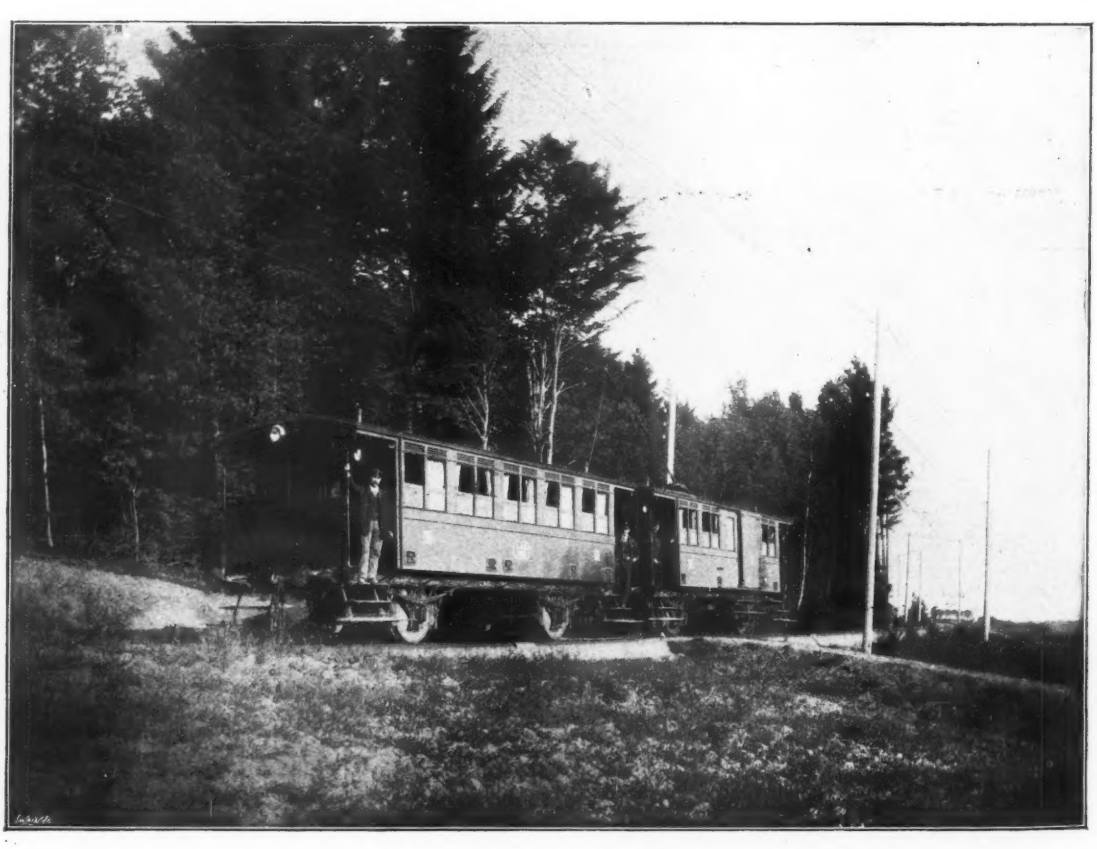


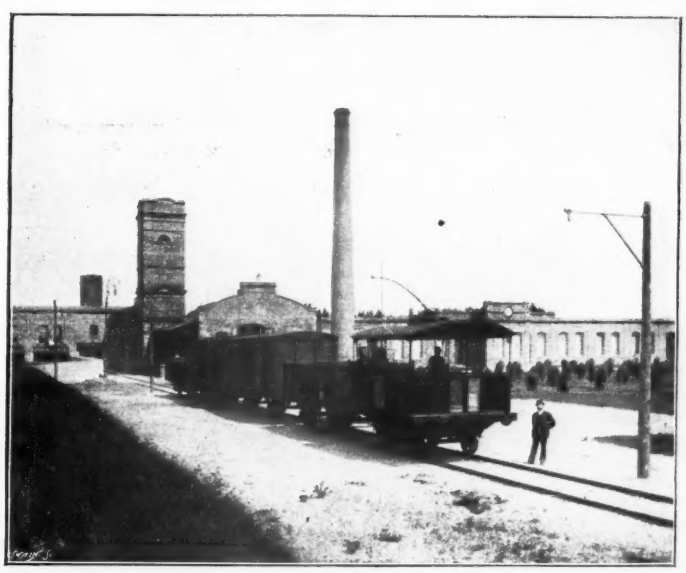
View of Car Sheds.



View of Rolling Stock and Track.

There are at present two power stations, water being the motive power in one, and steam in the other. This latter, however, is only used as a reserve when the water is rather low, or when there is a larger amount of traffic than usual. In the first station there are two Jonval turbines, one of 45 the other of 75 brake horse-power. Both these turbines drive by ropes on to a countershaft. This countershaft is in two parts, which can be connected by means of clutches. The electrical plant consists of one railway generator rated at 43 kw., but which can be worked up to 60 kw. if required. The current for the railway line is supplied at a pressure of 700 volts. There is also a 40-kw. alternator furnishing current at 2,100 volts. This is of the well-known Oerlikon type, having no rotating winding, and direct connected to its exciter. This machine is used for lighting purposes and for supplying power to stationary motors. Under ordinary circumstances the parts of the countershaft are not connected together, one section driving the railway generator and the other the alternator. The water-power is derived from a small river, by means of a canal about half a mile long a fall of 2·65 metres is obtained, the quantity of water being equal to 6 cubic metres per second.

The steam power station is designed to furnish 120 horse-power, but at present only 60 is installed. The plant consists of a water-tube boiler having a heating surface of 68 square metres, of one engine of 60 brake horse-power, and of a railway generator and alternator exactly similar to the one in the water-power station. Both the railway generators and the alternators in both stations can be put in parallel whenever required. The current from the water-power station is brought to Tettnang by means of an overhead line. Span wire construction has been adopted in the overhead line, the poles on one side carrying the telephone, telegraph, and test wires, those on the other side carrying the feeder cables for the railway as well as those over which the high pressure alternating current is transmitted. The trolley wire is suspended at a height of 5½ metres over the track.



Shunting Engine Used in Connection with the Meckenbeuren Line.

The negative poles of the railway generators are connected to the rails, and these are bonded in such a fashion that the resistance of the track does not exceed ·01 ohm per kilometre. The feed wire is connected with the trolley line every 200 metres. The feeders at each railway station pass through a switchboard, and are connected in such manner that any section can be cut out from any station. The water-power station is about 1½ kilometres away from the end of the line. The total length of the line is 4·5 kilometres, all of which is up hill; for 2·4 kilometres the gradient is 1 : 50. The radius of the sharpest curve is 150 metres. The rails used are of the Vignoles type, and weigh 21·96 kilogrammes per metre (about 44 lbs. per yard).

The rolling stock of the line consists of two motor cars divided into three sections, one carrying the mails, the other luggage, and the third passengers. Two motors are used to drive each motor car, each one of 24 brake horse-power. The motors run in series all the time. All the insulators used are of the well known Aetna material. It is intended to heat the cars in winter by electricity.

The weight of each car is 13,800 kilogrammes, and the wheel base 4·5 metres. These motor cars often haul trains weighing up to 55 tons, and at speeds which often go as high as 30 kilometres per hour.

The great development taken by goods and parcel traffic has made it necessary to instal a battery of accumulators at the water-power station, so as to be able to utilise the water-power to the utmost degree.

Weight of train in tons.		Time in minutes of journey.	Speed in kilometres per hour. Average.	On grades of 1 : 500.	1 : 200.	1 : 50.
Motor car alone ...	14	12	22	29	24	19
Motor car with trailer	33	18	15	24	18	14
" " " "	46·4	21	13	22	15	10·5

The success of this first main line electric railway is most encouraging, and there is little doubt but that branch lines of this description can be more economically equipped and worked by the overhead trolley than by any other system.

The illustrations we give are from photographs, and give a good idea of this interesting installation.

AMERICAN EXPERIENCE WITH HIGH VOLTAGE LAMPS.

High voltage lamps are steadily making their way in this country despite the inconveniences that attend their use. As time goes on, these will be reduced by the co-operation of the manufacturer, the central station engineer, and the wiring contractor. We know of several systems on which extensions at the higher pressure will be carried out, although in such cases there is a manifest disinclination to depart from the existing "declared pressure" in the area now under supply. One of our esteemed contemporaries, commenting on an article dealing with 200 and 220 volt lamps, said a short time ago that it had heard of troubles with high voltage in our columns, but apparently did not attach much importance to them, and seemingly had no knowledge that any unfortunate experiences had been met with in practice. That may be so, but, as a well-known station engineer pointed out to us the other day, lamps do flash over at the terminals of the filament in the bulb, and wiring contractors still put in pure rubber joints close together, if they are permitted, while central station men are anxious not to alter their street boxes unless forced to do so. Lamps are, however, slowly improving, and some samples now under test have proved much better than their predecessors, there being no tendency to short circuits at the terminals, or undue weakness in the filaments. Wiring contractors can be educated up to doubled pressure, and new designs of street boxes got out in which just a little greater clearance is allowed to guard against the rather greater risks that must be faced with the higher pressure. No one could be more anxious than we are to see this movement prove a success, but it is at least wise to hasten slowly.

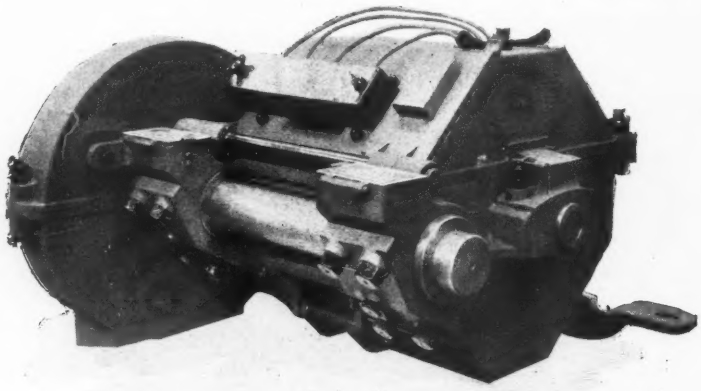
That we are not alone in taking up this position is shown by the articles that appear on the same subject in the American technical Press. From one of these we learn that 220-volt lamps were in use in two stations in the United States—Allegan and Detroit, Michigan—prior to the year 1894. In that year most of the experimental lamps were naturally crude and lacked efficiency, durability, and light giving power. Within the last two years at least 10 stations

have been established or reorganised, so that they work exclusively at the higher pressure. Many of those in contemplation, as well as private plants, intend doing the same thing. A curious fact about all these is that they are situated in very small towns, and their average capacity of plant installed is as low as 600 8-C.P. lamps, for supply to which one 50 or 60-kilowatt machine is considered sufficient.

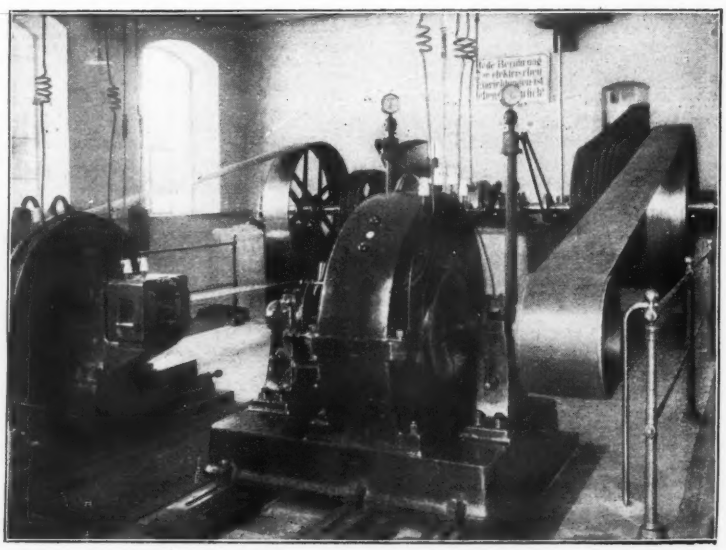
American lamps have the same deficiency that so far characterises those of home manufacture, that is, their low efficiency compared with what is claimed for those of ordinary voltage. Four watts per candle can be reached, but this is about the limit. If, however, this can be relied upon for all in a batch, and is maintained for the greater part of the useful life, there is little to complain about, as out of a large number of 100-volt lamps that have been tested while in common use, only a few take less than 60 watts for 16 C.P., and several take considerably more. We think that most central station engineers will agree with us that, in metering a consumer or calculating the probable load, it is not safe to allow less than that figure per 16 C.P. lamp. Eight C.P. lamps are in nearly all cases even worse than this, and ammeter tests of some recently delivered showed ·52 ampere, while giving a little over 9 candles at 100 volts. Such are the lamps that wiring contractors leave in consumers' fittings on completing a job.

We have been told that key sockets cannot be used safely with 220 volts. This is not our experience, nor does it seem to be that of our American friends. A good socket with ample clearance and rapid break stands the higher pressure seemingly without difficulty, and after running some during the winter of last year, and up to the present time, no untoward event has taken place. Fuses must be carefully watched, be only single pole, and properly grouped on well made distribution boards. Then, with carefully erected wiring, everything should go well. As our smaller towns and villages go in for electric lighting, the benefits of high voltage will become very apparent. Small stations must, above all, be simple, and nothing less liable to give trouble can well be imagined than a direct current two-wire system.

As an example of isolated plants, that at the Custom House in New York seems worthy of a brief description. There it is found that 220-volt lamps are at least equal to those of 100 volts in life and efficiency. The average life is given by American writers at from 1,200 to 1,500 hours. Sprague-Pratt electric elevators are run by the same plant at the lighting pressure, but with three direct coupled generators — General Electric (U.S.A.), 75 kilowatt 250-volt dynamos, and 120 H.P. "Ideal" engines running at 275 revolutions per minute — one is run separately on the elevator circuits, and the other two as required on the incandescent mains, with a battery of 130 chloride storage cells as auxiliary. This gives a flexibility to the generating plant, which is added to by a full complement of interchanging and regulating switch gear. The interior wiring was originally three wire, but has now been altered to suit the new conditions. The insulated conductors are carried by porcelain insulators, with iron armoured conduit for the mains. 1,600 lamps are fixed, and of these 600 are in constant use. A plant of this sort certainly gives 220 volts a fair trial.



Meckenbeuren-Tettnang Line—Motor of the Maschinenfabrik.



Meckenbeuren-Tettnang Line—Interior of Water Power House.

COMBINED CONDUIT AND TROLLEY ROAD.

Inasmuch as the day is not yet come, unfortunately, for the authorities of all the principal towns and cities to welcome the trolley wire throughout their chief streets (there never yet was a road or street "disfigured" by a tramway that would, could, or does look any the worse for a trolley wire), some considerable opening exists for combined working upon certain routes in the sense of a conduit for the crowded city streets followed by the trolley wire outside the town into the suburbs.

An instance of this was within an ace of coming into existence at Leeds, where, as most of our readers will remember, it was proposed at first to put in a short length of conduit for the central part of the Corporation tramway from Kirkstall to Roundhay, where it passes through one of the busiest streets in the city. But sound Yorkshire sense fortunately prevailed, and in the end it was decided to put up trolley wires throughout, patchwork methods not being approved of in this connection.

At Dresden and Hanover, experiments in a parallel course have been going on for some time, not however with conduit and trolley working, but with trolley and accumulator — another way of getting over the difficulty that is felt (though with no real reason) by some municipalities as to the erection of trolley wires in their central thoroughfares. So long as

makers of accumulators can be found to support such rather complicated—not to say expensive—methods, we shall doubtless continue to see combination working of the kind; "variety is, of course, charming," but another good proverb tells us to take a good thing and stick to it: wherefore the wise manager swears by trolley wires and makes money in proportion. In combined trolley and conduit working, the great difficulty, of course, is to effect with "neatness and despatch" the change from one system to another. About the feeblest device is to employ small dummy cars on the conduit section to provide the necessary contact with the conduit conductor: considerable waste of time is necessary for hooking on and detaching such a dummy car or even a plough alone to each trolley car as it enters and leaves the conduit section, while neither the electrical nor the mechanical arrangements are by any means easy for a device which drops down the plough from the motor car and lifts it up again somewhat after the fashion of a Ramsbottom steam locomotive water pick-up arrangement, though even this has been tried with more or less success.

An ingenious device for releasing automatically the contact plough for conduit working has, however, been developed on one of the American interurban roads (from Washington to Mount Vernon), and some few particulars of this—though by no means too many, if indeed enough for proper comprehension of all the details—are given in the *Street Railway Review*.

So far as it is possible to speak without actually seeing the device at work, one would feel inclined to say that the automatic release of a plough is quite well provided for by this device, which, indeed, almost leads one to hope and expect that the converse action of picking it up automatically will also be soon capable of accomplishment.

Described briefly, it may be said that by this method the contact plough is absolutely independent of the car: it is provided—about one-third of the way up from the contacts at the bottom—with two guide wheels or runners on each side which help to keep it in position upon slides attached to the truck, the wheels themselves running in steel [ ] channels attached to the base of slot rails. At the end of the conduit section, the slot is curved away towards the inner rail of the track, thereby forcing the plough sideways along the truck frame slides until it becomes detached altogether, resting them upon the guide wheels and channels. The latter curve downwards under a trap made to open and shut by a hand lever, so that the plough after sliding away from the truck frame literally dives downward by its own weight, through the trap opened to receive it, and then into a transverse pit where it passes to the other track ready to be attached to a car entering the conduit section.

Suitable insulated automatic contact plates are fixed on the top of the plough, making spring contact with transverse bars provided with terminals for cables from the motors, and carried on the truck frame above the slides for the plough.

It is stated that a speed of 10 miles per hour is maintained on the conduit section, off which the cars pass without stopping, as the trolley makes contact before the plough is released; the speed thereafter on the trolley section ranges up to as much as 40 miles an hour, the line being worked practically as a suburban railway over a distance of some 25 miles. For the trolley section current at a pressure of 500 volts is provided from two power houses. On the conduit section it is obtained at 220 volts from the local electric lighting company. One would be tempted to suppose that some difficulty might be found in working the conduit section even at this low voltage, seeing that the rails, motor frames, &c., must be grounded as usual for the trolley work, though obviously the danger to insulation would be much greater on a 500 volt circuit.

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 204.)

South African Telegraphs.—The British South Africa Company on Wednesday informed Reuter's Agency that they are advised by cable from Bulawayo that the telegraph line is open to Umtali, from Beira and Marandellas to Fort Salisbury, and that a break is being repaired between Marandellas and Umtali.

Offer to Lay a Cable from Spain to the West Indies,—A Spanish contemporary, the *Electron*, gives publicity to a proposal which has been laid before the Spanish Government by the firm of Messrs. Siemens Bros. & Co., and which, if carried out, will supply still another route for trans-Atlantic traffic. This proposition is regarded as encouraging to those who doubt the practicability of a Spanish cable worked by Spaniards. Our contemporary looks on the proposal favourably, but is not prepared to support the offer of Messrs. Siemens Bros. & Co. (which has been presented to the Government without having been officially asked for), as it is probable that more advantageous terms may be forthcoming when the Government invite tenders from the various companies interested in such work. The terms of the contract offered by Messrs. Siemens Bros. & Co. are given as follows:—1. They oblige themselves to construct and lay a cable which, starting from Santa Cruz de Teneriffe, goes to the Island of Viegnes (Puerto Rico), and from here to Havanna, with an intermediate station at San Juan de Puerto Rico. 2. They oblige themselves to lay the cable, and open the stations for service, within the space of one year from the date of contract. 3. All the material necessary for the installation will not be subject to Customs dues. 4. The total price, including all class of expenses, will be £1,350,000 sterling, at the rate of £350 per nautical mile. 5. The Spanish Government will provide the staff necessary for the working, and in case that the Government should not have a trained staff, the company undertakes to give such instruction in the requisite time. 6. For the payment of the cable, which will be made in London, they agree to the terms which the Government think convenient, up to the maximum limit of 30 years, an interest of 7 per cent. to be paid upon the amount payable. 7. In guarantee of the contract, they will lodge the security which may be required from them in Spanish bonds.

The Islet of Trinidad.—We read that Reuter's Agency is informed that only the formalities in connection with the recognition by Great Britain of the sovereignity of Brazil over the Trinidad Archipelago require to be completed, and that the question has been practically settled in favour of Brazil. The matter was not submitted to arbitration. The island came into prominence upon the proposal to make it a cable station between Europe and Brazil, but owing to its volcanic condition it has been found unsuitable for the purpose, and it has consequently again become of very small importance so far as Great Britain is concerned. The island is so beset with rocks that it is even difficult to effect a landing. The Brazilian Government is considering the advisability of building a lighthouse on an island of the group. So for the present ends "a not too creditable telegraphic intrigue," which has been a cause of worry and embarrassment to H.M. Government at an inconvenient time. The information supplied by Reuter's Agency is inexact as to the statement that it had been proposed to make Trinidad a telegraph station between Brazil and Europe; on the contrary, it was precisely in the threat to make use of Trinidad as a means of cutting Brazil out from the line of telegraphs running from South America to Europe, that this vexatious and futile *fiasco* originated.

The Telephone in Japan. Large Extensions.—Mr. Okomoto, engineer of the Ministry of Communication of Japan, recently inspected the Brooklyn, N.Y., telephone system. According to a contemporary, he said it was the intention to extend the telephone system over the entire Empire of Japan. A long distance line was now being constructed, he said, from Tokio to Kobi, a distance of 350 miles. There are no underground subways in Japan, and the wires are stretched from place to place by means of poles. Mr. Okomoto expects to visit all the larger American cities, and return home by way of San Francisco next month.

The Pacific Cable.—In the House of Commons, on Tuesday, Sir Charles Dilke said he hoped that nothing would be done to commit the country to a policy of subsidy to a cable across the Pacific, which had been recommended on military grounds. "Before we were committed to any large expenditure we should consider whether there were not other directions in which money might not be more profitably spent at this moment. All would hope that it would never be necessary to defend the Canadian frontier, even against a raid, but it was a weak frontier, and the organised Militia of Canada had neither money nor arms to make it possible for them to defend it so as to ensure communications at the early stages of the war. There was an alternative route that seemed to be more pressing, viz., that running from Gibraltar to Sierra Leone, the Cape, whence it branched off to Mauritius, and to Australia." Mr. Chamberlain, in reply, said:—I do not know whether the speaker entirely understands the position of the matter. The question was raised at the instigation of the Governments of the Canadian Dominion and the Australian Colonies, and it was necessary that an inquiry should be made, of course, in the hope that that inquiry would result in the laying of a cable, to the cost of which we might be willing to contribute. But up to the present time there is no pledge of any kind binding this country. All we are bound to is to make an exhaustive inquiry into the alleged advantages of such a cable, the best routes, cost, and subsequently into the proposals as to the proportion of contribution. Of course, a very important matter of this kind will not be finally decided without the House being asked to express an opinion upon it. I may, however, say with regard to the suggestion of my right hon. friend, that, of course, strategical reasons will have very great importance in deciding a matter of this kind. Hitherto the British Government has never subsidised a cable intended solely for commercial purposes, any subsidy having been justified on stragetical grounds. I cannot help adding that if we are to look at the comparison between this line and that suggested by my right hon. friend, there is this, at all events, to be said in favour of the Canadian-Pacific line, that we should have very large contributions from Canada and Australia, and that the subject is one which is very favourably viewed by those great colonies.

The Telegraph Wire Export Trade.—Although there was a rather more active tone in the export trade of this country in telegraph wire and apparatus connected therewith during last month, as compared with the preceding one, yet this branch of trade is just now in a very quiet condition. The value of the exports last month increased from only £19,680 in June last to £53,139; but the exports during the corresponding month of last year were valued at £82,421, while those for July, 1894, reached a total of £303,483. The total value of the exports during the first seven months of the year is returned at £396,402, as compared with £308,681 in the corresponding period of 1895, and £1,187,224 in the first seven months of 1894.

CONTRACTS OPEN AND CLOSED.

OPEN.

Denmark.—August 22nd. Tenders are being invited by the Lighting Committee of the Municipal Council of Copenhagen, for the supply of 20,000 incandescent lamps. Tenders to be addressed to the Directeuren for Belysning, Svalsen, Copenhagen.

Dewsbury.—August 22nd. The governors of the Dewsbury and District Technical School, invite tenders for the wiring and fitting of their premises. Plans may be seen at the office of the Secretary, from whom any further information can be obtained.

Holland.—August 26th. Tenders are being invited by the Dutch Minister of the Colonies at the Hague, for the supply of a quantity of galvanised iron wire, iron telegraph posts, and insulator supports &c.

Madras.—Nov. 11th. Lieut. Col. C. C. Rawson (in charge Consulting Architects' Division) invites tenders for the lighting by electricity of Government House, Madras, including the banqueting hall and the A.D.C.'s bungalow: also for the lighting of Government House, Guindy, including the Military Secretary's bungalow. Particulars to be obtained on application to the Consulting Architect to the Government of Madras, Chepauk, Madras.

Madrid.—October 8th. The Secretary of State for Foreign Affairs learns from her Majesty's Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez in Porto Rico. October 8th is the date fixed for the consideration of tenders, and such particulars as her Majesty's Government have received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

Mexico.—August 31st. Sealed tenders will be received by the secretary of the City Council of the City of Mexico, for the lighting of the city by electricity. All information and conditions of tender, plan of the city of Mexico, &c., can be obtained on application at the Mexican Consulate, Broad Street House, New Broad Street, London.

Oldham.—August 18th. The Electric Light Committee wants tenders for the supply of an electrically driven feed pump capable of delivering 2,000 gallons of water per hour against 125 lbs. steam pressure. Particulars from Mr. A. Andrew, Gas and Water Offices, Oldham.

Radcliffe (Lancs.).—August 17th. The District Council invites tenders for the supply and erection of a gas engine and dynamo, for lighting the Technical School by electricity, also for wiring and fitting the buildings for the purpose. Particulars from the Surveyor, Council Offices, Radcliffe.

Roumania.—September 4th. The Municipal Authorities of Jassy, Roumania, are inviting tenders for the electric lighting of the new abattoirs.

Southampton.—The time for sending in tenders for the electric cranes has been extended to August 31st, 1896.

Spain.—August 29th. The Municipal Authorities of Nava del Rey are inviting tenders for the concession for the electric lighting of the town during a period of 20 years. Tenders to be sent to El Secretario del Ayuntamiento de Nava del Rey.

CLOSED.

Bedford.—The following tenders were sent in for wiring for electric lighting the Working Men's Institute: Mr. Bacchus, £40; Messrs. Kilpin & Billson, £39; Mr. Crawley, jun., £37 12s. 6d. (accepted.)

Walsall.—The tender of Messrs. Babcock & Willcox for a water tube boiler for the electricity station has been accepted by the Town Council at £486 10s.

Wolverhampton.—The Town Council has accepted the tender of Messrs. T. Parker, Limited, for extensions to the electric lighting plant costing £955. Application will be made to the Local Government Board for a loan for this amount, and also an additional £600, for the purchase of a transformer.

INTERNATIONAL CONGRESS OF ELECTRICAL ENGINEERS AT GENEVA.

The Congress, which has just come to a close, was opened on August 4th by Mr. Th. Turrettini, the well-known designer of the turbines used at Niagara. Among the 230 members present, we may mention Messrs. Ferraris and Mengarini, from Italy; G. Kapp and Von Hefner-Alteneck, of Berlin; Mascart, Hillairet, and J. Blondin, of Paris; and Ch. S. Bradley, of New York. A few English electricians also attended the meetings, but the Institution of Electrical Engineers, of London, was not officially represented.

We cannot give a full account of the discussions, which lasted several days, but may briefly state the conclusions arrived at by the Congress.

The first report was by Dr. Wietlisbach, of Bern, on "Telephonic Disturbances Caused by Electric Traction." The following precautions were advocated:—

1. Where telephone wires cross a trolley line used for pressure not exceeding 750 volts, it is sufficient to protect the wires by fuses.
2. Where the pressure used is above 750 volts, the trolley line must be efficiently connected to earth.
3. The telephone companies are strongly recommended to use double wire.

On the question of *magnetic units*, a paper was read by Professor Ed. Hospitalier, of Paris, recommending the conclusions of the American Institute of Electrical Engineers. The Congress, after a long discussion, adopted the C.G.S. system as practical units, and gave the opinion that it was not necessary to use any special nomenclature. According to this decision such names of units as Gauss, Weber, Gilbert, &c., would be abandoned.

The report of Mr. André Blondel on "Photometric Units" was the next to be read. The decimal candle $= \frac{1}{20}$ violle, adopted by previous Congresses, is maintained. It can, however, be provisionally represented for practical purposes, and within a few per cent., by the Hefner lamp.

A table of units of light adopted by the Congress is given below:—

	Name of unit.	Definition.	Dimensions.
Intensity	Candle	I	I
Flux	Lumen	$\phi = I\sigma$	I
Illumination ...	Lux (= lumen square metre)	$E = \frac{\phi}{S}$	$I L^{-2}$
Brilliancy	Candle (per square centimetre)	$i = \frac{I}{S}$	$I L^{-2}$
Quantity of light...	Lumen-hour	$Q = \phi T$	I T

The opinion of the Congress was also solicited on the subject of the protection of overhead lines from atmospherical discharges. Various well-known magnetic and mechanic lightning arresters were advocated. The method of putting both poles to earth through a water resistance was said to give very good results. In the case of continuous currents, it was recommended to place in series with the lightning arrester a self-induction, and again between this and the dynamos, a capacity, the bed-plate, as well as both poles of the machine, being carefully insulated.

One day was devoted to the question of "Transmission of Power at Long Distances," Mr. Thury, of Geneva, defending, with much ability, his high tension continuous current system against all opponents.

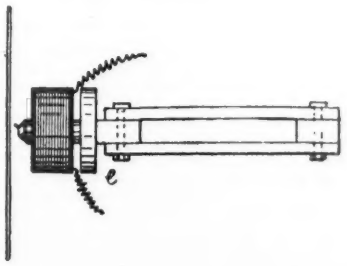
Much care was taken to provide accommodation and entertainment for the members of the Congress, and all foreign delegates were welcomed with the utmost cordiality and kindness. During the week several brilliant receptions were held, and various electrical works in the neighbourhood were visited. The Congress is being followed by an excursion, which will include visits to the most interesting technical installations in Switzerland.

Arc Lamps.—Professor Stine has been experimenting on carbons and arc lamps, and finds, as a result, that the general unsteadiness of these delicate and erratic mechanisms is not due to defects in the carbons, for the same carbons burned well in some lamps, and with enormous variations in current and E.M.F. in others. It seems that despite the fact that arc lamps are much more in vogue in America than here, they have not yet approached perfection. The arc lamp is necessarily a delicate apparatus, it must answer to very small variations such as 1 volt or 1 ampere, and at same time be simple and strong enough to be left in the hands of ordinary lamp attendants, conditions not easily met. The general conclusions of the professor are that a good lamp will burn well with any carbons, while a poor lamp requires first-class carbons of hard texture.

NOTES.

Motor Cars in the London Streets.—"It is very much to be regretted," says the *Engineer*, "that a procession of horseless carriages, motor cars, or whatever else their inventors and makers may call them, is to take place by way of jubilantly celebrating the passage of the Light Locomotives Act. Nothing better calculated to damage a good cause could be thought of. There is not at this moment a single vehicle in London which can be said adequately to represent what a horseless carriage ought to be, may be, and, we have no doubt, will be. If the procession idea is carried out without disaster, it is the most that can be expected, and at the best the general public will see nothing which can favourably impress any sensible man. We have always held that English engineers would not undertake the construction of such cars with any spirit until the law was so altered that that they might hope to reap some profit from their labours. Up to the present we have had with us nothing but French or American or German vehicles. We have no desire to write one word in disparagement of them; on the contrary, we regard them as very ingenious attempts to solve a perplexing problem, but the public in London will not regard them as somewhat crude experiments, and the mere sight of them in our streets will, we fear, strengthen the hands of those who are already but too willing that local authorities should make vexatious enactments. It ought not to be forgotten that, in spite of the Act of Parliament, Town Councils can lay a very heavy hand on the horseless carriage." From our own practical experience, we can corroborate all that our well-informed contemporary says regarding the far from satisfactory working of motor cars.

An Improved (?) Telephone Receiver.—In this receiver, shown by the figure, there is a thick copper disc, *e*, fixed in the proximity of the coil. *It is stated* that when this form of receiver is placed in circuit, and near to a powerful transmitter, the sound in the receiver is very much more powerful than in a receiver without the disc. When worked on a long circuit the power is the same as with an ordinary receiver, but much clearer. The receiver is the invention of Mr. S. D. Field, of America.



Researches on Storage Cells.—A good deal of discussion has recently centred around the question of storage cells, and especially in relation to the formation of persulphuric acid. Quite recently Elbs and Schönherr have stated that:—1. No persulphuric acid is formed when sulphuric acid of such strength as is used in storage cells is electrolysed with such current densities as occur there. 2. Persulphuric acid in dilute sulphuric acid solution has no oxidising action on lead oxide, and hence cannot be operated in storage cells. 3. The precipitate which was obtained by acting on lead acetate with potassium persulphate was simply lead sulphate, and contained no lead persulphate. To overthrow Darrieus's hypothesis, it would, in the opinion of Paul Schoop, be necessary to show not only that persulphuric acid does not remain in quantity after the action in the cell has stopped, but that it is not continuously formed and decomposed during the action, leaving only traces at the end. Those who are interested in following the author through his various arguments, will find them in a paper by Paul Schoop, *vide Zeitschrift für Elektrochemie*, Vol. ii., p. 273.

Relative Cost of Iron and Copper as Conductors.—The accompanying table, given by Mr. J. R. Allen in the *Technic*, shows the relative cost of copper in cents per pound as compared with wrought iron, Bessemer steel, and cast iron, in dollars per ton. The comparison is made for conductors having equivalent carrying capacity. In using Bessemer steel rails for conductors it is possible to use those that are winding and imperfect. Such rails may be purchased at a greatly reduced price. Let us consider the saving that can be made by the use of Bessemer rails, assuming the rails to cost $25 per ton, as compared with copper at 11 cents per pound. Let the current to be transmitted be 1,000 amperes at 500 volts, and the distance it is to be transmitted be three miles, with 5 per cent. drop in voltage.

Cost of copper, in cents. per lb.	Cost of equivalent wrought iron conductor in dollars per ton.	Cost of equivalent Bessemer steel conductor, in dollars per ton.	Cost of equivalent cast iron conductor, in dollars per ton.
7·	19·25	18·10	14 50
7·5	20 75	19 50	15·50
8·	21·50	20·30	16·75
8·5	23·75	22·25	17·75
9·	25.00	23·50	19·00
9·5	26·50	25 00	20·00
10·	28 00	26·25	21·00
10·5	26·25	27·50	22·00
11·	30 75	29·00	23·00
11·5	32 25	30·25	24·25
12·	33·50	31·75	25·25
12·5	35 00	33 00	26·25
13·	36 50	34·50	27·25
13 5	38·00	35·75	28·50

Cost of copper conductors...	$39,000
Cost of Bessemer steel conductors	23,711
Difference...	$5,289
Deducting $400 per mile for bonding	1,200
Total saving	$4,089
Saving per mile	1,363

The first use of steel rails as conductors was on the intramural road at the World's Fair. The New York *Electrical Engineer* says that the Metropolitan Elevated Road of Chicago has also adopted steel rails as conductors.

Probing the Wound.—The following comments regarding a prospectus recently laid before the British public are taken from last week's issue of *Money*. It will be interesting to see what answer the board gives.

London Electric Omnibuses.

The London Electric Omnibus Co. was formed to work "Ward's" system, the patent for which was originally granted in 1888. As yet, all companies of this kind must be regarded as born out of due time, for the running of motor carriages on the public roads is not yet legalised. Yet this undertaking was described in the prospectus as "a sound progressive industrial British enterprise." Let us see what faith the British public has in it, as tested by the amount of capital subscribed. £170,000, in £1 shares, was offered for subscription. Will it be credited that, instead of getting even within sight of this figure, the directors have gone to allotment on a subscription of £21,900 only—that is, only about one-eighth of the capital they wanted. According to the prospectus, £20,000 in cash is to be paid to the vendor for an "exclusive license" to work the patents in England. This leaves, therefore, only £1,900 of working capital, with which princely sum it is proposed to provide and work 125 omnibuses for London, besides paying the expenses of floating a number of subsidiary companies for provincial towns. The idea of providing 125 electric omnibuses out of £1,900—or about £15 per 'bus—is somewhat comic. The company must be endowed with miraculous powers to do it. Whatever the merits of electricity as a motive power, it is too early yet for companies of the kind to enter the field.

If the sum mentioned by our financial contemporary is correct, it would seem that the directors were somewhat injudicious in going to allotment, although probably under the circumstances the vendor has not received anything like the sum the prospectus named as being his share of the undertaking.

Appointment Vacant.—The Wallasey District Council want an assistant electrical engineer at £150 per annum. For further details see our "Official Notices."

Organic Membranes as Insulators.—Some recent experiments by Sir B. W. Richardson on organic membranes as insulators, are described in a recent number of the *Lancet*. The experiments were made by placing the membranes on a platinum disc connected to one pole of the battery, the other pole of the latter being connected through a galvanometer to a platinum probe, which was touched on the upper surface of the membranes to be tested. The results in all cases were that no deflections were observed, and Sir Benjamin concluded from this that the membranes "resisted the current as effectively as a layer of India-rubber or gutta-percha would have done." It is much to be regretted that Sir Benjamin is not more perfectly acquainted with electrical testing, otherwise he would hardly have jumped to the conclusions he has. As regards the arrangement of the apparatus, this is all right; but we have no details about the figure of merit of the galvanometer, it is simply stated to be a "delicate" one. Was it wound to a "high" or a "low" resistance; if the latter, then no matter how "delicate" it may be, it is absolutely useless for insulation testing. Again, what is the use of using a probe? this would only submit an infinitesimally small portion of the membrane to the current; a second disc ought to have been used. All that the experiments proved was that the membranes did not conduct well, not that they insulated well; they might have had a specific resistance which was a mere fraction of that of gutta-percha or India-rubber, and yet be sufficiently high not to show a deflection on the apparatus used. No deflection does not necessarily mean infinite resistance, or indeed anything near it, we would remind Sir Benjamin. An American contemporary, it should be noted, accepts the experiments as being satisfactory! When will people learn to discriminate between the value of negative and positive results, and how is it the *Lancet* was not sharp enough to pick a hole in Sir Benjamin's conclusions?

A New Glow Lamp.—This lamp, which has recently been invented in Germany, consists of a "glow plate" connected at each side by a platinum wire, and inserted in a glass bulb and the air extracted, as in ordinary glow lamps. The "glow plate" is manufactured of pure, unpressed, and hygroscopic asbestos fibre, cut into strips of about 3 mm. thickness and about 6 cm. long. Such a strip is firstly saturated with a 30 per cent. platinum chloride solution, and secondly, passed through a solution of saturated sal-ammoniac, and is then dried in hot air. Then it is converted into spongy platinum by heating it in Bunsen burner. Then, after saturating it in a 20 per cent. magnesium chloride solution, it is again heated white hot in a Bunsen. This last process is repeated until the filament has received an even cover of magnesium. The melting point of platinum does not affect the usefulness of this filament, as the cover of magnesium protects it. As the lighting capacity of the alkaline earths is about three times as great as that of carbon, it is said to be possible, by using this lamp, to save much current. The manufacture of the lamp is comparatively cheap; that as the resistance of this glow material is much greater than the resistance of carbon, the lighting surface can be made much greater than in ordinary glow lamps.

Northampton Institute.—The appointments recently advertised at this Institute were filled at a meeting held on Monday last. The following were among the successful candidates: Head of the Mechanical Engineering and Metal Trades Department—Mr. John Ashford, who has been for the last three years Lecturer on Engineering at the Birmingham Technical Schools. Chief Assistant in the Applied Physics Department—Mr. C. V. Drysdale, a distinguished student of the Finsbury Technical College, and the Central Technical College, South Kensington, where he obtained two diplomas of Associateship in Physics and Engineering respectively. Since his college training, Mr. Drysdale has been for three years employed with Messrs. Nalder Bros. & Co., the well known electrical instrument makers.

Wiring Rules.—We have received a copy of the revised regulations issued by the Manchester Corporation with regard to the wiring of consumers' premises. We understand that the chief points in which Mr. Wordingham has altered these rules relate to the supply of current for motors, and the supply of current at a pressure of 200 volts for lighting purposes.

A Correction.—Mr. Voysey, the City Electrical Inspector points out that a paragraph which appeared last week on the subject of gas explosions in the City, attributes statements to him which he never made. The note in question was founded on information which was given in two City papers (including the *City Press*). It is obviously wrong in one respect, viz., that 2,000 boxes per week are regularly inspected by the Board of Trade. We regret that the error was repeated in this journal, and if Mr. Voysey will point out the other mistakes we will readily rectify them.

A Generous Offer.—One of the speakers at the recent dinner of the Tramways Institute expressed himself very strongly as to the growing importance of electric traction, and offered to "swap his old knife for a bicycle," as the boys say, or, in other words, exchange three or four of his electric lighting jobs for a single one in electric traction work. This "wos werry kind and considerate of the genelman," seeing that although his staff may be able to guide him in electric lighting matters, their want of experience and his with regard to electric traction affairs would fill a very big book.

Gas Accidents.—A gas explosion at the Moorhead Arcade, Moorhead, on 7th inst., did considerable damage.

A gas explosion, attended with serious results, occurred on 10th inst. at the premises of a butcher in Railton Road, Brixton. Several persons were badly injured.

Main Box Explosion.—We understand that about 9.30 o'clock Wednesday evening, an explosion took place in the electric light main box at the corner of Vere and Oxford Streets. The pavement was blown up, but no one was injured.

Personal.—The Postmaster-General has consented to hold office as Mayor of Sheffield for another year.

NEW COMPANIES REGISTERED.

Tavernier Safety Motor Syndicate Limited (48,938).—Registered July 25th, with a capital of £3,000 in £50 shares, to adopt an agreement with A. E. Tavernier, and to carry on the business of patentees, motor manufacturers, cycle and carriage manufacturers and dealers, electricians, mechanical engineers, fitters, &c. The subscribers (with one share each) are:—G. W. Fardell, 27, King Street, Cheapside, barrister; M. J. Shepherd, 4, Hyde Park Mansions, W., gentleman; E. C. Lowdell, 5, Bathurst Street, W., gentleman; J. D. Carmichael, 2, Copthall Buildings, E.C., gentleman; P. E. Carapata, 13, Sutherland Avenue, Maida Vale, gentleman; A. E. Tavernier, 35, Plato Road, Brixton, S.W.; H. McDowell, 31, Alford Road, Park Lane, W., gentleman. The first directors are H. T. D. Sweet, A. E. Tavernier, and G. W. Fardell. Registered by A. H. Bradley, 27, Gracechurch Street, E.C.

"Motors," Limited (48,979).—Registered July 28th. Capital £5,000, in £1 shares, to enter into an agreement with S. L. Phillips, and to carry on the business of electricians, engineers, suppliers of electricity, and apparatus manufacturers. The subscribers are:—B. Pell, 35, Netherhall Grove, N.W., electrician, 200 shares; A. Bergtheil, 38, Warwick Road, Paddington, electrical engineer, 100 shares; H. W. Young, 20, Goldhurst Terrace, N.W., electrician, 100 shares; E. S. Eccles, 23, Hertford Street, Mayfair, W., electrician, one share; F. B. Pell, 35, Netherhall Grove, N.W., electrical engineer, one share; E. Forrest, 75, Barrow Road, Streatham, electrician, one share; S. Smith, 27, Wray Crescent, N., clerk, one share. The number of directors not to be less than three, nor more than seven; the subscribers to appoint the first. Remuneration as the company may decide. Registered office 12, Camomile Street, E.C.

Anglo-French Motor Carriages Company, Limited (48,992).—Registered July 29th, capital £300,000 in £1 shares, to enter into an agreement with E. Roger, and to carry on the business of manufacturers of, and dealers in, motors, and motor cars, cycles, velocipedes, tramcars, vehicles and carriages, manufacturers of, and dealers in, steam, oil, gas and electrical engines, motors and dynamos, launch and boat builders, mechanical and electrical engineers, machinists' fitters, millwright founders, wire drawers. The subscribers (with one share each) are:—C. Luff, Woodham, Addlestone, Surrey, clerk; E. Sorrell, 50, Idminston Road, Stratford, E.; G. A. Roos, 167, Cromwell Road, S.W.; C. C. Weells, 1, Millfields Road, Clapton Park, N.E., clerk; S. E. Newman, 72, Romolly Road, Finsbury Park, N., clerk; F. Morton, 4, Bidwell Street, Peckham, S.E., clerk; G. Beeson, 2, Clarendon Terrace, W. The number of directors not to be less than three nor more than ten; the subscribers to appoint the first; qualification £200; remuneration £1,500 per annum, and a share in the profits, divisible. Registered office, 58, Coleman Street, E.C.

Motor Car Syndicate of Australia, Limited (49,019).—Registered July 31st. Capital £5,000, in £1 shares, to manufacture, sell, and deal in auto-motor cars, carriages, cabs, omnibuses, tram cars, railway coaches, vans, bath chairs, cycles, velocipedes, ships, &c. The subscribers (with one share each) are:—W. Jordan, 55, Highbury Park, N., agent; H. W. Jordan, 120, Chancery Lane, W. C., agent; A. E. Jordan, 120, Chancery Lane, W.C., cashier; T. Shields, 8, Bell Yard, Temple Bar, director; W. C. Gurney, 22, Stanley Road, N., clerk; H. C. Newman, 230, Lancaster Road, W., clerk; W. T. Jones, 17, Penford Street, S.E., clerk. The number of directors not to be less than three, nor more than seven; the subscribers are to appoint the first; quallfication £100; remuneration as the company may decide. Registered by Jordan and Sons, 120, Chancery Lane, W.C.

Electrical Development and Finance Corporation, Limited (49,021).—Registered July 31st, capital £500,000 in £1 shares, to promote and facilitate the development of undertakings for electric lighting, electric traction, electric power supply, electric communication, and other industrial purposes connected with electricity in any part of the world, and to enter into an agreement with E. Colman. The subscribers are:—Newcastle, 11, Hill Street, peer, 250 shares; W. Crookes, 7, Kensington Park Gardens, W., 250 shares; C. Johnson, The Dignaries, Blackheath, S.E., engineer, 250 shares; G. Newington, 76, Ordine Road, East Dulwich, one share; C. T. Price, 5, Prince Arthur Road, Hampstead, solicitor, one share; J. Stewart, 24, Cecile Park, Crouch End, N., accountant, one share; N. G. Newington, 76, Ondine Road, East Dulwich, clerk, one share. The number of directors not to be less than two nor more than seven; the subscribers to appoint the first; qualification, £250; remuneration, £200 per annum (£300 for chairman), and a share in the profits. Registered by Renshawm, Kekewich & Smith, 2, Suffolk Lane, E.C.

Davies Motor Company, Limited (49,068).—This company was registered on August 7th with a capital of £160,000 in £1 shares, to enter into an ageeement with Alternate Current Electro-Motor Syndicate, Limited, for the purchase of certain patents and other rights and properties, and to carry on the business of electricians, electrical manufacturers, electrical engineers, light and power contractors, and makers of dynamos, motors, apparatus, and fittings. The subscribers (with one share each) are:—G. W. de Tunzelmann, 6, Penywern Road, S.W., electrical engineer; C. E. Cree, 12, Nevern Road, S.W., barrister; A. W. Cree, Brodsworth, Beckenham, solicitor; W. L. Davies, 57, Comeragh Road, West Kensington, electrical engineer; A. Davies, 16, Red Lion Street, Clerkenwell, electrical engineer; H. E. Cree, Bemenden, Eastbourne, solicitor; J. W. Phillips, 18, Mayflower Road, Clapham Road, S.W., clerk. The number of directors is not to be less than three nor more than nine; qualification, £100; remuneration, £200 each per annum. Registered office, 13, Gray's Inn Square, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Telegraph Manufacturing Company, Limited (34 23,482).—This company's annual return was filed on July 30th. The capital is £50,000, in £10 shares, and 3,661 have been taken up. 646 have been considered as paid, and the full amount has been called on the rest, resulting in the receipt of £30,150.

F. H. Royce & Co., Limited (41,362).—This company's annual return was filed on June 9th. The capital is £30,500, in £1 shares (of which 500 are deferred). 17,954 ordinary and 500 deferred have been taken up, and 12,514 ordinary have been considered as paid. £1 per share has been called on the rest, and £5,940 has been paid.

Evershed & Vignoles, Limited (43,206).—This company's annual return has just been filed. The capital is £10,000 in £10 shares, and 753 have been taken up. The full amount has been called, and £7,530 has been paid.

CITY NOTES.

Central London Railway Company, Limited.

At the half-yearly ordinary general meeting of this company, held at Cannon Street Hotel, on Tuesday, Mr. Henry Tennant presided.

After the secretary had read the notice convening the meeting,

The Chairman said there were now 904 shareholders on the list. At this stage of the history of the railway there is not much to say, but the directors pointed with satisfaction to the fact that a good beginning of this great work, the Central London Railway, had been made. Possession of sites had been obtained for the stations mentioned in the report (which appeared in our last issue), and the work of sinking shafts had been commenced at several of these places. At Queen's Road and Newgate Street the requisite property had not yet been acquired for the stations there, but negotiations are in progress. At Newgate Street, a more extensive station than was originally contemplated is to be constructed, as extensions or alterations later on would cost considerably more. The engineers report that satisfactory progress has been made with the preparation of the ironwork for the tunnels and the necessary machinery. The outlay during the half-year had amounted to £273,812, making a total outlay of £442,098. The Electric Traction Company had shown every desire to press on with the work as far as possible. After some remarks regarding the special meeting which was to follow for the purpose of passing resolutions allowing a division of the shares, the Chairman moved the adoption of the report and accounts.

The motion was seconded by Lord Colville of Culross, and carried unanimously.

At the extraordinary general meeting, the following resolution, moved by the chairman, was carried unanimously:—1. "That every share in the company's capital upon which not less than 60 per cent. has been, or shall at any time have been, paid up, and with respect to which the directors shall at any time have received a notice in writing signed by the holder or holders thereof signifying his, her, or their desire that such share should be divided, shall upon receipt of such notice as aforesaid be divided into two half-shares, of which one shall be called 'Preferred half-share,' and the other shall be called 'Deferred half-share.' 2. That upon every such division 50 per cent. upon the entire share shall be carried to the credit of the deferred half-share (being the whole amount payable thereon) and the residue to the credit of the preferred half-share. 3. That the interest which would, under the powers and provisions in that behalf in the company's special acts, from time to time or at and time be paid or payable on any divided share if the same had continued an entire share, shall be applied in payment of interest on the two half-shares, in proportion to the amounts credited as paid up on such half-shares respectively. 4. That the dividend which would from time to time be payable on any divided share, if the same had continued an entire share, shall be applied in payment of dividends on the two half-shares in manner following—that is to say, first, in payment of a dividend at the rate of £4 per cent. per annum on the amount for the time being paid up on the preferred half-share, and the remainder, if any, in payment of dividend on the deferred half-share, but so that no greater amount of dividend shall be paid on the two half-shares than would from time to time have been payable on the entire share if the same had not been divided. 5. That the directors be, and are, hereby authorised to do all acts and things necessary for giving effect to the foregoing resolutions."

The usual vote of thanks closed the meeting.

Liverpool Overhead Railway Company, Limited.

The sixteenth half-yearly general meeting was held at the Law Association Rooms, Liverpool, on Tuesday last, Sir William Forwood, chairman of the company, presiding.

The Chairman, in moving the adoption of the report and accounts, touched upon the principal features in them. He thought he might claim that they were very satisfactory. They showed that the traffic on the railway was making steady progress; that the line was being daily more largely availed of by the commercial community of the port, and was being largely patronised by visitors to the city and sightseers. They had earned during the past half-year £31,286, and had expended on the working of the line £19,694, leaving a profit of £11,592. Out of that they had paid for interest on mortgage debentures £2,500, leaving £9,092. They had brought forward a balance from last half-year of £2,074, and that gave them a total of £11,166, with which they had now to deal. They proposed to pay 5 per cent. preference dividend, amounting to £2,700, and a dividend of 2½ per cent. per annum on the ordinary share, amounting to £5,568, leaving a balance to carry forward of £2,897. In the corresponding half of last year they paid 2¼ per cent. per annum on the ordinary shares, and carried forward £1,300. They were now carrying forward a larger balance than some might think necessary, but if they paid a dividend for the year of 3 per cent., as probably they would, they should have to pay a larger sum to the tramway company. The receipts had increased by £3,000 over the same half of last year, and there was also an increase in the expenses of about £1,000. Of the latter sum £400 represented an extra amount they had had to pay in rates, over which they had no control. In other words, they had earned £3,154 more during the half-year, at an extra expense of £641. They had carried 3,739,575 passengers, being an increase of 279,000 in the six months, or over half a million more for the year than in the previous year. The average receipts per passenger were 1·96d., against 1·92d. in the same half of last year, and the revenue per train mile had been 15·10d., against 14·38d. He thought all these items were of a very satisfactory and gratifying character. The board were determined to keep the structure in the best possible condition, and they were now using their electric power for the purpose of painting the railway. They did that by means of a machine, which put on the paint in the form of a fine spray, and which was worked from the electric conductor on the railway. In that way the cost of labour was reduced almost by one-half, or in the proportion of 11s. 6d. instead of 20s. The cost of working per train mile during the half-year had been 3·40, against 3·49 in the same half of last year. He regretted that the works at the southern extension had been somewhat delayed, owing to unexpected difficulties of construction in connection with the crossing of the Cheshire Lines Railway. They were now, however, in a very forward condition, and he thought that portion of the line might be open for traffic on November 1st next.

Mr. Richard Hobson seconded the motion.

A Shareholder asked how long the payment of £1,000 per annum to the tramway company was to go on.

The Chairman said their agreement with the tramway company was on a sliding scale. They were to pay according to their dividends. They paid £1,000 at present, but when they paid a 3 per cent. dividend they would have to pay another £1,000 to the tramway company, and if they paid 4 per cent. there would be a third thousand. The agreement was subject to six months' notice on either side. During the first two or three years of the railway they had very fierce opposition from the tramway company, which was no doubt doing them a considerable amount of injury. An agreement was afterwards made, whereby they were to pay to the tramway company £1,000 per annum, subject to earning certain dividends, and the tramway company undertook to work certain lines as feeders for the railway. They also undertook to advertise the railway in every omnibus in Liverpool. The board now contemplated approaching the tramway company to try and obtain some modification of these terms.

The motion was then carried unanimously, as was also a proposition for the payment of the dividends stated in the chairman's remarks.

Replying to a vote of thanks to the directors, the chairman said he had been informed by a railway expert that he did not know of any railway in the United Kingdom that had ever paid 3 per cent. dividend in the same period as the Liverpool Overhead Railway.

This terminated the meeting.

The Chili Telephone Company, Limited.

The ordinary general meeting of this company was held at Winchester House, on Friday last, Mr. Keith in the chair.

The Chairman said the shareholders would be pleased to see that the business of the company had made considerable progress during the past year; the accounts were the most satisfactory the company had yet had. The gross revenue amounted to $619,826, or over 11 per cent. more than for the previous year. That was principally due to the increase of 237 subscribers, and in a lesser degree to an increased use made of the trunk line service. The total working expenses amounted to $384,979, or 62 per cent. of the gross revenue, as compared with 65 per cent. in the previous year. The general expenditure for the year showed a marked reduction, which with the increase of revenue, was most satisfactory, and reflected great credit on their general manager for the economies he has effected. The adoption by Chili of a gold standard had made the exchange during the year 17½d. to $1, which, compared with 13 61d. of the previous year, which had considerably enhanced the sterling value of the net income at Chili. The net profit amounted to £8,551, as compared with £6,013 of the previous year, or an increase of £2,538, which enabled the board to recommend the payment of a dividend of 4 per cent. on the shares. The general bad state of business, which unfortunately still continued, had lessened the satisfactory result of the year's working, by diminishing the actual increase of subscribers. The telephone was different from other business, such as the telegraph, for in that the change of customer did not matter much; to the telephone company it meant additional expense, without any increase of revenue whatever. The cost of joining new subscribers up had added considerably to the expenses, without adding to the revenue. During the year the company's property had been considerably improved and extended; the property throughout was in very good condition, with the exception of some of the older lines, which their manager reported required to be put in a state of repair. People of Valparaiso used the telephone very extensively, and they had ordered a new multiple switchboard, and hoped to have it installed before the end of the year. Their object was to give their subscribers a perfect service, and to secure to the shareholders a fair return on the capital invested. The opposition company, to which he alluded last year had opened an exchange at Valparaiso, but their operations had not affected the Chili Company to any appreciable extent. They had not lost any subscribers in consequence, and they had reason to think the service they gave would retain their support. He spoke of the benefits that would accrue from the settlement of the boundary question and the change in the monetary conditions. He then moved the adoption of the report, which after some little discussion was adopted.

Manchester Edison-Swan Company, Limited.

The annual meeting of this company was held on Fyiday at 65, King Street, Manchester. The directors' report stated that the net profit, including last year's balance, amounted to £2,041 18s. 1d. Out of this it was proposed to pay a dividend at the rate of 5 per cent. per annum, which will absorb £1,500, and to carry forward the balance, amounting to £541 18s. 1d.

Mr. V. K. Armitage, chairman of the company, in moving the adoption of the report, incidentally referred to the competition, not only keen but, he said, unscrupulous, to which the company was subjected by its rivals in its efforts to obtain business.

Mr. W. P. James Fawcus, in seconding the motion, explained that the electric installation at Altrincham, on which there was last year a loss of £400, had now begun to pay. The number of customers was steadily increasing. The Altrincham Electric Supply, Limited, had also got a provisional order for supplying the electric light to Ashton-on-Mersey, and in all probability a beginning would be made with the laying of the mains within the next month or two. At a comparatively small outlay they would thus be enabled to tap another populous district and to increase the profits of the company.

The report was unanimously adopted, and the dividend recommended by the directors was declared payable. Thanks were accorded to the directors for their services, and a sum of £250 was voted to them.

The Cuba Submarine Telegraph Company, Limited.

The report of the directors for the half-year ending June 30th, 1896, to be presented at the fiftieth ordinary general meeting of shareholders, to be held on August 19th, 1896, states that the gross receipts amount to £36,186 19s. 2d., and the gross expenditure to £9,425 1s. 3d., leaving a sum of £26,761 17s. 11d., which, added to the balance brought from the last account, £3,719 2s. 5d., leaves £30,481 0s. 4d. at the credit of revenue account. The increased traffic, and the cost of working the five new stations of the Cienfuegos-Manzanillo cables, which were opened on January 1st, account for the increase in the stations expenses. The sum of £17,910 9s. 4d. has been added to the reserve fund, which now stands at £98,000, after deducting the cost of the cables between Cienfuegos and Manzanillo. The dividend on the preference shares will absorb £3,000, and leave £9,570 11s., out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income-tax, the balance, £3,170 11s., being carried forward to the current half-year. The cables have continued in good order since the date of the last report. The company's suit against the Spanish Government at Madrid has recently come before the Contencioso Court, which has declined to cancel the Royal order complained of on the ground that no injury has been done to the company by the said order. In the event, however, of injury arising in consequence of said order, the company is left free to take such action as may be necessary to protect its interests. The director who retires from the board at this time is Mr. Charles Woodbyne Parish, who, being eligible, offers himself for re-election. Mr. John Gane, the auditor, also retires, and offers himself for re-election.

Imperial Tramways Company, Limited.

The ordinary general meeting was held at Bristol on Monday, Mr. Geo. White presiding.

The Chairman, in moving the adoption of the report, said the prospects of the Middlesborough Tramways undertaking were improving, and at Reading there were evidences of development, the profit there being sufficient to pay 6¾ per cent. upon the Reading share capital. Extra expenditure, had, however, been incurred, in order to meet omnibus opposition. Referring to the successful introduction of electric traction on the Dublin undertaking, he said, having opened the tramway, they were enabled to demonstrate the value of the property, and the constructors (the British Thomson-Houston Company), who owned the preference and debenture capital, ultimately agreed with them to purchase the whole ordinary share capital, which the Imperial Company owned, for a sum of £130,000, subject to the payment by the Imperial of certain liabilities of the Dublin Southern Tramways Company. The latter, on their part, had also since been able to effect a sale practically of the whole concern to the Dublin United Tramways Company, at a sufficient sum to cover the outlay and the purchase price paid to the Imperial. It had, he thought, been a very satisfactory deal all round. The accounts showed that they had received a cash deposit of £30,000 on account of the purchase, and that the balance was payable at the end of the half-year. The gross revenue—omitting all credit on the Dublin account—amounted to sufficient to pay debenture interest, preference dividend at the rate of 6 per cent. per annum, and a dividend on the ordinary at the rate of 2½ per cent. per annum.

The report was adopted, and the proceedings in connection with the sale of the company's interests in the Dublin Southern Tramways Company were approved.

The Hong Kong Electric Company, Limited.—As the result of the year's work ending April 30th, 1896, after deducting directors' fees $2,000, there is left an amount of $30,119.23 available for appropriation, and the directors recommend that this be disposed of as follows:—

To pay a dividend of 5 per cent., say 40 cents per share	$12,000.00
To write off plant account for depreciation	10,000.00
To carry forward to next account	8,119.23
	$30,119.23

Electric Construction Company, Limited.—The transfer books for the ordinary and preference shares will be closed from August 13th to 27th, inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending August 9th, 1896, were £895; week ending August 11th, 1895, £860; increase, £35; total receipts for half-year, 1896, £5,419; corresponding period, 1895, £5,084; increase, £335.

The Great Northern Telegraph Company. The traffic receipts in July 1896, amounted to £24,600; 1st January to 31st July, 1896, £163,600; corresponding months, 1895, £174,300; corresponding months, 1894, £155,400.

The Liverpool Overhead Railway Company. The receipts for the week ending August 9th, 1896, amounted to £1,700; corresponding week last year, £1,578; increase, £122.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 7th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited were £2,711.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Aug. 5th.	Closing Quotation, Aug. 12th.	Business done during week ended Aug. 12th, 1896. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	8½— 9½	8½— 9½	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	52 — 54	52 — 54	52½	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	97½— 98½	97½— 98½	98½	97½
2,993,560£	Do. do. Defd.	Stock	...	...	...	9 — 9⅛	9 — 9⅛	9⅛	9⅛
120,000	Brasilian Submarine Teleg., Ltd.	10	6⅛% §	7 %	...	15¼ — 15⅝	15¼ — 15⅝	15¼	...
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	5 %	112 —116	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	4 %	3½ — 4	3½ — 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	1⅛%	1⅛%	1/16— 3/16xd	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½ — 13½	12½ — 13½	13	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½	3½ — 4½	4½	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	107 —110 %	107—110%	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	2½%	9⅜— 10¼	9⅜ — 10¼	10⅛	9⅞
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	6½%	17¾ — 18¼	18 — 18⅛	18⅜	18 1/16
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	6	18½ — 19½	18½ — 19½	19⅜	18
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	104 —107 xd	104 —107	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	131 —134	131 —134	133	132
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	18 — 18½	18 — 18½	18½	18⅜
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	100 - 104	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	130 —133 xd	130 —133	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	100 —104	100 —104	...	...
107,600£	Do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	105 —108 xd	105 —108	106	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	111 —114 %	111 —114 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝% §	4½%	4½%	11½— 11⅝	11½— 11⅝	11⅝	11⅝
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	6 %	17¾ — 18¼	18 — 18⅜	18 5/16	18⅛
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝% §	8⅝%	10 %	23½ — 24½	23½ — 24⅝	24¼	23⅝
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	53 — 56	53 — 56	...	...
100,000£	London Platino-Brasilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	111 —114	111 —114	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5½%	7¾— 8	7¾— 8	8	7¾
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	17½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	17 — 18	17 — 18	17⅛	17 5
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅞— 7⅛	6⅞— 7⅛	7	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	107 —110	107 —110	107¾	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4½%	5 %	⅜ — ⅞	⅜ - ⅞	13/16	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 —111	108 — 111	...	
11,839	Reuter's Ltd.	8	0 %	*nil*	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 —145	140 —145	...	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	4 %	3¾ - 4¼	3¾ — 4¼	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	101 — 106	101 —106	101	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	4 %	5 — 6	5 — 6	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	106	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	*nil*	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	8 %	99 — 104	99 —104	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	3 %	8¾ - 9¼	8¾— 9¼	9⅛	8 13/16
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	7 — 7½	7 — 7½	...	...
33,129	Do. do. do. Def. Ord.	7½	..	1 %	1 %	2¼ - 2⅜	2¼— 2⅜	...	...
165,200£	Do. do. do. 5 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107 xd	103 —107	106¼	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107 xd	103 —107	...	..
88,321	West India and Panama Teleg., Ltd.	10	1⅞%	1⅞%	1⅞%	1½ — 1⅝	1½ — 1⅝	1 5/16	1 3/16
34,563	Do. do do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11½— 12	11½— 12	11⅜	11⅜
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½— 10½	9½— 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ..	$1000	7 %	7 %	7 %	110 —115	110 —115	...	...
164,300£	Do. do. 6 % Ster. Bonds. ...	100	6 %	6 %	6 %	104 —107	104 —107	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	8½— 8⅝	8⅝— 9½	8 13/16	8⅝
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7¾— 8½	7¾— 8½	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4½%	114 —116	114 —116	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	15 — 16	15½— 16½	16½	15½
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17xd	17 — 18	17⅝	17½
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —137	133 —137	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	*nil*	8 — 9	8 — 9	9	8¾
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	...	6 %	13½— 14	13¾— 14	...	...
10,000	Do. do. do. iss. at 2 pm., £1 paid	10	...	...	...	3½— 4½	3½— 4½	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	4 %	13½— 13⅝	13½— 13⅝	13⅝	13½
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	119 —123	1 9 —123	122	121
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	11 — 12	11 — 12	11 1/16	11½
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	12½— 13½xd	12½— 13½	12 15/16	12 13/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	5	4 %	5 %	7 %	11 — 12	11 — 12	11⅝	11½

* Subject to Founder's Shares.

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation Aug. 5th.	Closing Quotation, Aug. 12th.	Business done during week ended Aug. 12th, 1896. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	5 % §	2½%	...	1 — 1¼	1 — 1¼	1 5/16	1
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	3 %	...	1¼— 1½	1¼— 1½	1⅜	1¼
125,000	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	112 —115	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	98 —102	98 — 102	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	10½—11	10½— 11	...	...
207,649	Do. do. do. £2 paid	10	...	...	...	2¼— 2½	2¼— 2½	2⅜	...
630,000	City and South London Railway	Stock	1 1/16%	1½%	1 5/16%	45 — 47	46 — 48	47½	46⅝
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 % §	*nil*	*nil*	2 — 2½	2 — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	5 %	1⅞— 2¼	1⅞— 2¼	2 9/16	2
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	5 %	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	4½%	103 —106	103 —106	104	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	5 %	1½— 1⅝	1⅝— 1⅞	1 13/16	1⅝
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2½— 3	2⅝— 3⅛	3⅛	3
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	5/8— 7/8	5/8— 7/8	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	3/8— 5/8	3/8— 5/8	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	10½%	10½— 11½	10½— 11½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	17½— 18½	17½— 18½	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	17½— 18½	18 — 19	18½	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	109 —114	109 —114	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	22 — 23	22 — 23	22⅝	22½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	106 —109	106 —109	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅞%	13⅜— 13⅞	13⅜ — 13⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	17⅛— 17⅝	17⅛— 17⅝	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	39 — 42	39 — 42	...	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	8 — 8½	8 — 8½	8 5/16	8⅛

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50 % for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—6%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 104—107.

House-to-House Company (£5 paid), 4—4⅛.

Do. do. 7 % Preference, of £5, 8⅛—9.

Do. do. 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 9½—10xd; 1st Preference Cumulative 6 %, £5 (fully paid), 7⅞—8¼.

London Electric Supply Corporation, £5 Ordinary, 1—1⅛.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7⅛—7⅜.

Bank rate of discount 2 per cent. (February 22nd, 1894).

ALTERNATE CURRENT TRANSFORMERS.

By Dr. J. A. FLEMING, F.R.S.

Society of Arts Cantor Lectures. Lecture IV., delivered February 10th, 1896.

(*Concluded from page* 189.)

The Employment of Transformers.

In this last lecture I wish to direct your attention to certain problems in connection with the employment of transformers. I shall assume that the majority present are quite familiar with the ordinary methods of distributing electric current by means of transformers, whether by what is called the system of distribution by house transformers, as shown in fig. 47, or the more modern and economical method by transformer sub-stations. Generally speaking, the method of transformer distribution which is now found to be most practically useful in provincial towns and over large areas is somewhat as follows:—In the generating station, the alternators either send their current into one common set of omnibus bars, the alternators working in parallel, from which bars a distribution is made by high tension feeds to various transformer sub-stations, often a more complicated switchboard is employed in which the high tension feeders coming from the various transformer sub-stations can be connected at pleasure to any alternator, or grouped together in any way on one or more of the alternators. It would be foreign to our subject here, at the present moment, to enter at all into the question of the parallel working alternators. It has been fully discussed in the technical journals and other publications. The high tension feeders are generally arranged to convey a high tension current at a pressure of 2,000 volts to certain transformer sub-stations in which are placed a bank of transformers. These transformers take their primary current through primary switches and fuses from primary omnibus bars connected to the feeders, and the secondary circuits of the transformers are generally arranged to feed a three-wire system of low-tension distribution. For this purpose each transformer is provided with three secondary terminals, and from the sub-station proceeds a three-wire low-tension system which is fed by one or more of the transformers, and to which the consumers are connected. In joining up a bank of transformers in this manner it is important that each of the transformers should have an equal percentage secondary drop for the same fraction of full load. Otherwise, if one transformer has a smaller secondary drop than another, that transformer with the least secondary drop will take the greatest share of the load as the sub-station is loaded up, and it may, therefore, get overloaded and get very hot, and such an inequality of load tends to increase, the more the bank of transformers is loaded up. It is always advisable to examine transformers in this manner, and if any transformer is found to have too large a secondary drop then to remedy it by adding one or more turns to the secondary circuit. In addition to a low tension distribution from transformer sub-stations it is sometimes found convenient to run one or more high-tension feeders to supply the outlying regions of the district which is then served with a system of house transformers. The plan which I have found convenient to adopt in developing an alternating current station in a provincial town in which there is a central shop district, in which the lighting is rather dense, and an outlying residential district in which it is rather scattered, is to arrange one or more low pressure secondary networks on the three-wire system in the central portion of the town. Each of these networks is fed from a single transformer sub-station, and the secondary circuit forms a complete ring main, which is fed into by secondary feeders at three or four places. The transformer sub-stations are inter-connected by a high pressure connecting main, which serves, in case of breakdown at one station, to allow the duty of that station to be taken up by another sub-station. It is not advisable, in my opinion, to connect together the different, separate, secondary networks. One great advantage of the alternating current system is that it enables us by having small separate secondary distribution systems perfectly insulated from one another, to limit the effect of a dead earth on one of these secondary networks, and that is an advantage which cannot be obtained on the ordinary low pressure system where the distribution network is connected throughout.

As regards the description of cable to be employed, it is now well understood that concentric cable forms in all cases the most satisfactory of cable both for the high pressure and the low pressure conductors. By the employment of concentric cable, we eliminate at once any difficulties which would arise due to induction taking place on neighbouring telegraph and telephone wires: and we also largely reduce the inductive drop in pressure which would otherwise exist if the three members of the secondary circuit were separate cables separated by any distance from one another. My own experience is that the secondary network is best laid down by means of triple concentric cable, and there are certain advantages in making the outer member of this cable the middle wire of the three conductor system. In any case, the house connections are quite easily made. It is also desirable to get rid altogether of distribution boxes and service boxes, which become localities in which coal gas can collect and occasionally explode. In laying down the secondary distribution system by means of lead covered and armoured triple concentric cable, by far the best plan is to make the proper connection with a service main to each house at the time that the cable is laid, and to have this joint entirely sealed up in lead, making use of no junction box at all, or at most of right angle iron sleeve to mechanically protect the joint. The service

main can then be taken into each shop or house, and connected up to the consumer's terminals, whether the building takes light or not. In the central portions of a town it is only a question of time for every shop or house to take the current, and it saves expense ultimately to make this joint in the first instance. The secondary cable having been laid in this manner should be tested, and my own practice is to insist upon a test of 1,000 volts between the different members of the secondary circuit when it is laid in the earth, but before the house connections are made. If the cable stands this test it has a large factor of safety. With regard to the high pressure cable, it is customary to use ordinary duplex concentric cable, and if the service is a 2,000 volt service, then after the cable has been laid in the ground it should be tested by a pressure of 4,000 volts placed between the inner and outer members for one hour, and a pressure of 2,000 volts between the outer member and the earth, and the cable should not be accepted unless it has passed this test. As it is always desirable to use concentric cables in connection with all modern transformer systems of distribution it is necessary to pay attention to some peculiar effects which are observed in connection with concentric cables when supplying transformers, and during the remainder of the lecture I propose to occupy your attention chiefly with practical points connected with these effects. They may be divided into four classes. There are first those which may be called the resistance effects, which are effects connected with the distribution of the current over the cross section of the conductor employed for the transmission of the alternating current. Secondly, there are the capacity effects, which depend upon the fact that a concentric cable is a large condenser or Leyden jar. Thirdly, there are the resonance effects, which are due to the reaction of this capacity upon the alternators, or the primary transformers. Fourthly, there are effects which may be called the initial stage effects depending upon the capacity of the cable, and the inductance of the transformers supplied through it, both of which co-operate together to produce peculiar effects at the moment when the cable carrying the transformers is switched into connection either with another live cable or with an alternator. We shall consider each of these in turn. It will be necessary to preface a detailed discussion of these effects by some general remarks upon the nature of current flow in inductive circuits. Every electric circuit which has self-induction or inductance and capacity has a natural period of electric vibration—that is to say, if the electric charge in it is disturbed, and then left to itself, it oscillates backwards and forwards as water would do in a long tube having the ends closed by elastic caps. In such a case, if the water was disturbed and then left to itself, it would oscillate to and fro in virtue of the fact that the mass of water possesses inertia, and that the elastic caps on the ends of the pipe permit the water to be displaced. In other words, such a closed pipe has what may be called hydraulic inertia and permittance. In the same manner, a circuit which has self-induction possesses what may be called electric inertia or inductance, and a condenser which permits of electric displacement to be made through its dielectric or non-conductor has what is called capacity or permittance. If a condenser with a capacity, C, is being charged through a resistance, having a value represented by R, the product, C R, is called the time-constant of that system, and it represents the time in which the charged condenser, if left to itself, short circuited by the resistance, R, would fall in potential to a certain fraction (very nearly two-thirds of its original potential); again, if L is the inductance of a conductor, and R is its resistance, then $\frac{L}{R}$ is called the time-constant of that circuit, and this is the time in which a current in that circuit would rise to about two-thirds of its full value if a constant electromotive force is put upon the ends of the inductive resistance. The first product, C R, is called the electrostatic time-constant of the condenser and resistance, and the quotient, $\frac{L}{R}$ is called the electro-magnetic time-constant of the inductive resistance. If, then, we join together in series a condenser having a capacity or permittance, C, and an inductive resistance having an inductance, L, and a resistance, R, it can be shown that the complete, free, periodic time of oscillation of a charge of electricity in that system is given by this expression:—

$$t = 2\pi\sqrt{\frac{L}{R}\,C\,R}.$$

In other words, the complete periodic time is equal to 2π times the geometric mean of the electrostatic and electro-magnetic time constants. It must be noted that this is the time of oscillation of the charge when left to itself, but it is of course perfectly possible to make what is called a forced oscillation, and that is what is done in every transformer system. These electrical quantities have their mechanical analogues. Suppose, for instance, we take a pliable lath with a weight on it, and fix it at one end, the pliability of the lath is the analogue of the capacity of the electrical system, the mass of the weight on the end is the mechanical analogue of the induction of the system. If then we displace the lath, or bend it, and leave it to itself, it vibrates to and fro with a natural period of its own, in virtue of the fact that the system has pliability or permittance, and mass or inductance. If the mass be small, and the pliability is small, the time of vibration is small; but if the pliability is great, and the mass is great, then the time of vibration is great. Such a loaded flexible rod not only has a free period of vibration of its own if fixed at one end and set in oscillation, but we may give it a forced oscillation. Before explaining the manner in which certain electrical effects may be mechanically imitated by such a loaded lath, we will consider a little more in detail the properties of concentric cables when used with alternating currents. In the first place, a cable intended for use with an alternating current must not have the metal or conductor of which it is made of a thickness exceeding a certain value, for the reason that a certain time has to elapse before the current is established in the central portions of the conductor, and, therefore, if the conductor is used with alternating currents, its actual resistance depends upon the frequency and the thickness of the conductor. Without going into more elaborate explanations on this point, for which I refer the reader to other text-books, I may give here a table showing the resistance of high conductivity round copper conductors to continuous and alternating currents of a certain frequency, the results of which are set out graphically in a curve in fig. 48.

The following Table shows us that practically the largest conductor which should be used in connection with alternating current work is a cable having an outside diameter equal to a 19/12 cable, and that if the cable has a greater diameter, then its resistance to alternating currents of a frequency 100 is sensibly different from its resistance to continuous currents. In the next place, with regard to capacity, suppose that a concentric cable is formed by putting one cylindrical tube in the interior of another cylindrical tube, the space between the tubes being occupied by non-conducting material or dielectric having a specific inductive capacity equal to K; then, if R_0 is the radius of the inside of the outside tube, and R, is equal to the radius of the outside of the inner tube, and if L is the length of the tubes, the capacity of this concentric cable in microfarads is given by this expression:—

$$C = \frac{K\,L}{2\,(\log R_0 - \log R,)\,2{\cdot}303 \times 9 \times 10^5}$$

Then, as regards the value of K for paper insulation, such as is used in the Ferranti cables, K has a value very nearly equal to 3; but, if India-rubber is used, then K has a value very nearly equal to 4. On calculating out these values for most ordinary cables used for the conveyance of high tension alternating currents, it will be found that for such insulating materials as paper, Fowler-Waring composition, or various resinous substances, the capacity of the cable is generally about one-third of a microfarad per mile.

Table of Resistance of High Conductivity Round Copper Conductors.

Cable. Strands and size.	Total cross-section area in square inches.	Resistance in ohms per 1,000 yards. For continuous currents.	Resistance in ohms per 1,000 yards. For alternating currents. Frequency 100 ~ per second.
7/18	·0126	1·974	1·974
7/17	·0172	1·452	1·452
7/16	·0225	1·108	1·108
7/15	·0285	·878	·878
7/14	·0351	·712	·712
19/18	·0351	·712	711
19/17	·0477	·524	·524
19/16	·0624	·401	·401
19/15	·0789	·318	·318
19/14	·0973	·257	·257
19/13	·1269	·194	·195
19/12	·1615	·153	·155
19/11	·2048	·122	·1247
19/10	·2500	·100	·1034
37/16	·1227	·204	·2041
37/15	·1551	·162	·164
37/14	·1913	·131	·1334
37/13	·2534	·099	·1024
37/–	·3000	·083	·087
37/12	·3235	·077	·081
37/11	·4000	·063	·068
37/10	·4905	·051	·057
61/15	·2582	·097	·1004
61/14	·3185	·078	·082
61/13	·4218	·060	·065
61/–	·5000	·050	·056
61/12	·5385	·046	·052
61/–	·6000	·041	·048
61/11	·6476	·039	·0465
61/–	·7000	·0357	·0435
61/10	·8167	·0305	·0391
91/13	·6354	·0385	·0458
91/–	·7500	·0330	·0412
91/12	·8111	·0305	·0391
91/–	·9000	·0277	·0370
91/11	1·0000	·0250	·0350

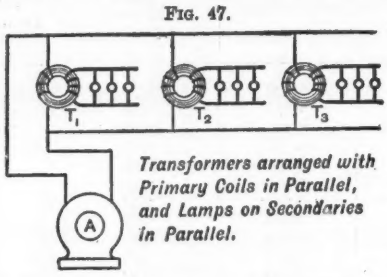
From what has been said above with regard to the resistance effect, it must be noted that in the construction of a concentric cable the maximum thickness of the copper conductor cannot be more than about ½ inch. In cases where larger currents have to be conveyed than can be carried through the equivalent of a 19/12 cable, it is desirable to employ two concentric cables in parallel. Let us consider, then, the capacity effects. If a long concentric cable is connected to an alternator, the far end of the concentric cable being insulated, it is found that an electric current flows into and out of the cable, which may be sufficient to light one or more incandescent lamps. This is called the capacity current of the cable, and it is a current flowing across the dielectric or non-conductor from one copper member to the other. If C is the capacity of the cable measured in microfarads, V, the difference of potential between the two copper members measured in volts, and if p represents $2\pi n$, where n is the frequency, then the capacity current I is given by this expression:—

$$I = \frac{C,\ p,\ V}{10^6}.$$

Thus, for example, supposing a cable, having a capacity current one-third of a mile capacity, has a potential difference of 2,000 volts

between its inner and outer conductors, and p equals 500, then the capacity current is $\frac{1}{3}$rd of an ampere, or equivalent to the lighting current of one 8 candle-power lamp. Hence, in very large concentric systems, this capacity current going out of the station may amount to a considerable value. We have then to consider briefly what are called the resonance effects. If an alternator is separately excited so as to give a certain potential difference at its terminals, suppose 2,000 volts, and if a long length of concentric cable is connected to this alternator, the far end of the cable being insulated, then it will be found that such cable, when associated with the alternator, may greatly increase the electric pressure between the terminals of the alternator, and that for a certain critical length of the cable a very marked rise in pressure may take place. The same will be found to be the case if a long length of concentric cable is connected to the high pressure side of a step-up transformer being excited from a 100-volt alternating circuit on the low pressure side. Accordingly, in testing concentric cables, the engineer must always be on his guard against this resonance effect. Suppose, for instance, it is desired to test whether a certain length of concentric cable will stand 2,000 volts, the most natural method of doing this would be to connect the high pressure side of a step-up transformer, raising the volts from 100 to 2,000, and to serve the low pressure side of this transformer from a 100-volt circuit. The inexperienced person might naturally suppose that this would invariably place upon the cable a pressure of 2,000 volts, but under certain conditions, depending upon the capacity of the cable and the inductance of the transformer, the pressure might rise far beyond 2,000 volts between the two members of the cable, and the only method of making sure that this is not the case is to have an electrostatic voltmeter kept connected between the inner and outer members of the cable as the pressure is gradually increased.* Then, in the last place, not only are there the resonance effects above referred to, by which a concentric cable when switched on to an alternator or transformer permanently raises the pressure, unless the exciting current of the alternator is reduced, but there are certain very important initial effects which take place at the moment when a concentric cable is switched into connection with either an alternator or another live cable. If a condenser is connected with an

FIG. 47.



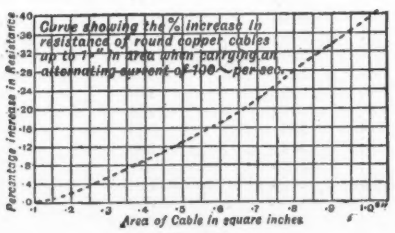

Curve showing the % increase in resistance of round copper cables up to ½" in area when carrying an alternating current of 100 ~ per sec.
Percentage Increase in Resistance
Area of Cable in square inches

FIG. 48.

inductive resistance, it can be shown that at the moment when this system is brought into connection with the source of alternating electromotive force, if the connection is made at a particular instant with respect to the phase of the electromotive force, there is an electrical oscillation set up in the combined condenser and inductive resistance, the amplitude of the oscillations of current greatly exceeding those which would exist when the steady state has been established, and oscillations of potential difference occur at the same time, the result of which is that the difference of potential between the two plates of the condenser will undergo a periodic change, the amplitude of the oscillations of which is, however, in the initial stage much greater than that of those which take place when the whole system has settled down into a steady condition under the influence of the impressed periodic electromotive force. Suppose, then, that a series of transformers are connected to the two copper members of a concentric cable, and that the concentric cable is, as usual, lead covered and steel armoured with a layer of insulation between the lead covering and the outer copper members. As already stated, there is a certain capacity in the concentric cable between the inner and the outer members, which will be generally something like one-third of a microfarad a mile, but, at the same time, there will be a capacity between the outer member of the concentric cable and the lead casing or the earth; and this capacity between outer and the earth, as it is called, is very much larger in general than the capacity between the inner and outer; it may be 10 times as great. Hence, if the transformers are connected between the inner and outer conductors we may regard the primary circuits of the transformers, which are inductive circuits, as connected in series with a condenser, which is formed of the outer members of the cable and the lead covering. If, therefore, such a cable, with transformers attached to it, the secondary circuits of which are unloaded, is switched into connection with the omnibus bars of an alternating current station, the connection between the inner member of the cable with the proper omnibus bar being made first, then, at that instant, an electromotive force is impressed upon the system, consisting of the inductive primary circuits and the condenser in series with them. For a particular phase of the impressed electromotive force, it can be shown that oscillations of potential are set up in the condenser, causing a periodic potential difference between its two sides to be greater than that due to the steady action of the periodic electromotive force. This sometimes results in breaking down the insulation between the outer members of the concentric cable and the lead covering, and as this insulation is generally in all cases made much thinner than that between the inner and outer members of the cable it is not unfrequently pierced. Alternating current station engineers are very familiar with failures of such concentric cables occurring between the outer members of the cable and the earth. The remedy for this is one of two things, first the *outer* member of the concentric cable must be connected to its proper omnibus bar *first* before the inner member of that concentric cable is connected. If this is done, then it is impossible to set up destructive oscillations of pressure between the outer members of the cable and the lead covering. Another remedy is to introduce in the circuit with the inner member of the concentric cable a variable inductance, which is gradually removed in such fashion that the inner member of the concentric cable is not connected suddenly with the source of potential, but is connected through a choking coil, the choking quality of which is gradually removed. This can be done in the following manner. A large transformer is arranged so that its secondary circuit can be gradually short-circuited by lowering two lead or iron plates into an insulated tub of water; the primary circuit of this transformer can be connected in series with the inner member of the concentric cable, which is to be brought into connection with the system. The operation, then, of connecting the long concentric cable to the omnibus bars is as follows:—The series transformer first has its secondary circuit opened, its primary coil is then connected in series with the inner members of the concentric cable to be connected, and with the proper omnibus bar, the outer member of the concentric cable is then connected with the other omnibus bar, the plates on the secondary circuit of the series transformer are then gradually lowered into the water, and when the secondary circuit of this series transformer is practically short-circuited the primary circuit of the transformer is also short-circuited, and the transformer is then removed, leaving the main in connection with the omnibus bars. The operation, moreover, is performed in such a manner that there is no rush of current into the cable, and no possibility of setting up violent oscillations of potential between the outer members of the concentric cable and the earth. In no case should long concentric bars be connected to omnibus bars or to other parts of an alternating current system without some such process as the above, of gradually setting up the full current in them, or else the risk of piercing the outer insulation of the concentric cable is very considerable. Engineers, in connection with alternating current stations, should always be on their guard against these initial effects, and remember that long concentric cables, with transformers connected to them, possess a quality which resembles inertia, and that currents can no more be started and stopped instantly in these cables and transformers than heavy machinery can be started and stopped at once.

In addition to the initial effects taking place in cables, I showed, in 1892, that there were certain initial effects, called current rushes, taking place in transformers when suddenly switched into connection with a live cable. Under some circumstances, depending upon the phase of the electromotive force in which the switch is closed, a strong rush of current may take place into the primary circuit of a transformer, the maximum value of that current rising to twice the maximum value of the current when the steady state is established; and, under some conditions, in switching off a transformer, there may be a certain rise in the difference of potential between the parts of the primary circuit and the iron case or secondary circuit which may pierce the insulation. If a large current is flowing in an inductive circuit, and a switch is suddenly opened, interrupting that circuit at an instant when the current has its maximum value, then a large inductive electromotive force is set up in that circuit, which may result in breaking down the insulation between parts of that circuit. The effect arises from the same cause that frequently destroys the insulation of a field magnet of a continuous current motor or dynamo if the field magnet is suddenly switched off at a moment when the magnet is in a state of excitation.* Broadly speaking, as a practical rule, it should be remembered that long concentric cables, having transformers lightly loaded connected to their ends, should never be suddenly switched into connection with alternators, or switched off, but should always be put into connection with the source of electromotive force through a regulating resistance or inductance, so arranged as to prevent or check the formation of any oscillations of current other than those due to the natural period of the impressed electromotive force. In the early days of the working of many large alternate current stations, many difficulties were experienced, owing to the failure of large transformers, and the piercing of long concentric cables, which were due to these causes; but experience has now shown how to overcome these difficulties, and to prevent any of these disastrous initial effects. In many cases cables and transformers, which suddenly fail when switched into connection with the circuit, after being idle for a time, have really been injured at the instant when they were last switched out of connection with the working system, owing to the rise of potential that has taken place at the instant when the current was interrupted at a particular instant

* For a further discussion of these resonance effects, the reader is referred to "The Alternate Current Transformer" (Fleming), Vol. ii., p. 383, *et seq.*, where a full discussion of these effects in connection with concentric cables is given.

* For further information on these initial effects, see "The Alternate Current Transformers," Fleming, new edition, Vol. i., p. 201. Also the *Electrician*, Vol. xxx., p. 543, L. Neustadt, "On Concentric Cable Phenomena."

during its phase. Hence the removal of a cable from a working system at the omnibus bar, or at any intermediate point, must always be effected with the same care as the connection of a cable, and in no case should a long concentric cable, whether connected to tranformers or not, be switched on or switched off from the live omnibus bars of the station abruptly. This, of course, does not apply so much to short lengths of a few hundred yards as to long lengths of one or more miles; but it behoves the engineer always to be on his guard against these sources of failure.

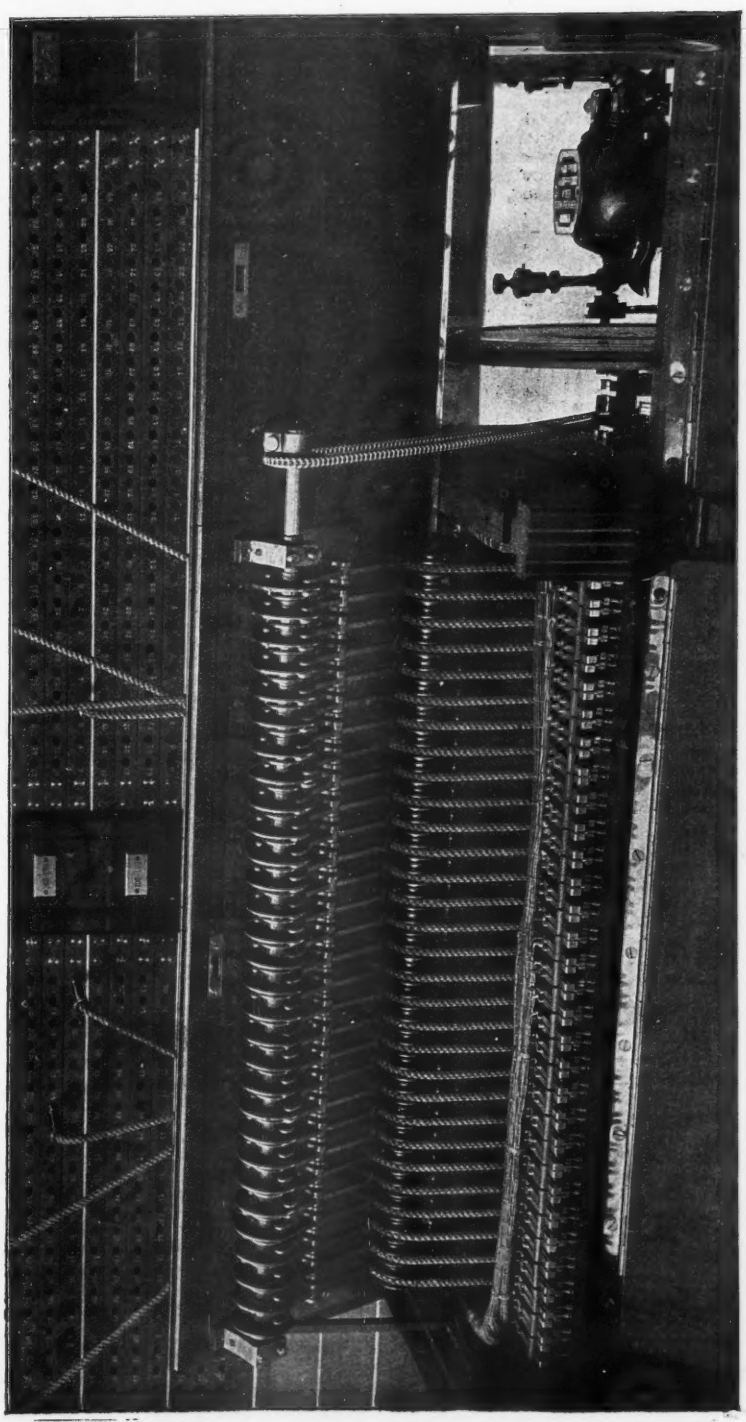


Fig. 7.—The Hess-Ravebot-West System of Telephone Exchanges.

The time will not allow me now to develop at any greater length these points, and in closing this brief discussion on the construction and action of transformers, there is no need to emphasise the fact that much has perforce been omitted, owing to the limits of our time, which a complete treatment would necessarily include. I have endeavoured to direct attention rather to a few principal practical considerations, and to portions of the subject not quite elementary in character, and to assume, as I said at the beginning, that the fundamental principles were already familiar to most present.

Great as has been the progress in 10 years in alternate current working, no one would be so rash to assume that we have reached the limit of its improvement. The practical perfection of the transformer placed in the hands of electrical engineers an instrument of enormous utility and power for effecting the distribution of electric current. Large as may be our indebtedness to those whose scientific and constructive ingenuity has brought about this advance, we must at the same time remember, with due meed of honour and praise, the pioneering experiments of Paul Jablockoff and Lucien Gaulard, in 1887 and 1882, which, even if not the first suggestions for the employment of the induction coil in electric lighting, certainly forced the attention of engineers to consider closely the value and use of that device, and the service it might be brought to render in the solution of the problems of public and private electric supply.

THE HESS-RAVEROT-WEST SYSTEM OF TELEPHONE EXCHANGES.*

By J. H. WEST.

(*Concluded from page* 172.)

The actual construction of this device is shown in fig. 7, which shows the connection board with the peg shelf turned up. To the right is seen the small shunt wound motor, which slowly drives the commutator axle by means of a chain and sprocket wheel. This axle carries the 30 discs corresponding to the 30 communication cords, and is carried by two brackets, which, as well as the bearings of the levers, are screwed to a metal plate underneath the peg-shelf. Instead of being driven by friction, as said in the description of the diagram, fig. 6, the discs are actually driven by means of a simple toothed gearing. The contacts, f_1, f_2, f_3, f_4, c_1, c_2, of the diagram, as well as the connecting wires, may be seen in front of the cords.

In order to ensure that the weights on the cords fall entirely unhindered, sheet-iron partitions are placed between them. The restoring device of the ring-off indicator, S, K, consists of a ball-crank lever, H_2, turning about the fulcrum, i_2, and a small straight lever, h, which gears with it and turns about i_3. If S_2 is raised, the right-hand end of H_2 rises, and the upper end of h is turned to the right. When the final signal is given, the drop, a, is freed, and falls forward until it rests on h; when S_2 is withdrawn from the jack, it falls on H_2 and turns it, and consequently h and a_1 back into the position shown in the diagram.

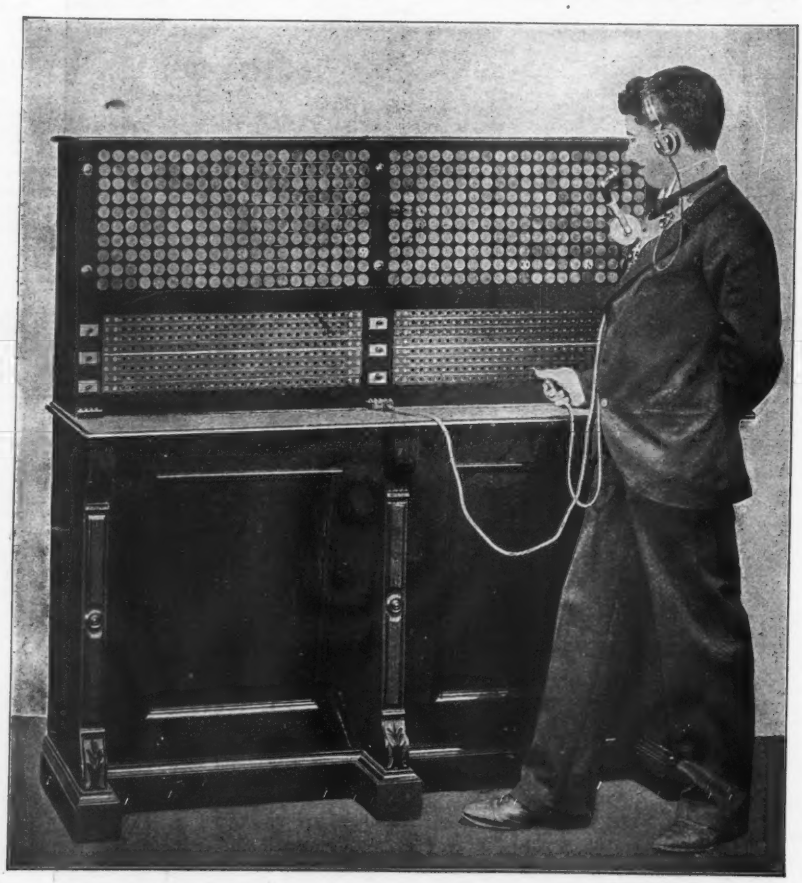


Fig. 8.

The call-board, fig. 8, is divided into sections of 200 subscribers each; each section comprises a glow lamp panel, with 200 lamps, and below a jack panel with the same number of jacks; in addition, to the left of each jack panel, are three speaking keys for the lines to the three sections, *ab*, *ac* and *ad*, of the connection board. The glow lamps are arranged in rows of 20, as shown; each of them is enclosed in a brass tube, the front end of which is closed by a disc of dark green glass; on the back of this glass disc is a thick dead white band of paint, in which a number is cut, and behind the glass disc is a second one of dead white parchment paper. With this arrangement the number is not visible when illuminated from the front; but when the glow lamp behind lights up, it appears green against a dark ground, since the band of paint is not transparent.

The 20 lamps in each row are fixed in an iron strip, S, fig. 9, the 10 iron strips of all the lamps of one board being connected through the return strip, *r*, with one pole of a battery. In this common return is connected up a "warning lamp," which always lights up whenever any one of the corresponding 200 subscribers' lamps lights; the operator has not, therefore, to watch the whole lamp panel, but only the warning lamp, as this apprises him of the arrival of a call; this much facilitates the work, especially when one operator has to attend to several boards during the night. Behind the iron strip is a wooden batten, L, to which are fixed the contact springs, *f*, for the base contact of the glow lamps. The tube, R, is fixed on the metal lamp-holder, *m*, by means of a bayonet joint, and can, therefore, be readily removed when a spent lamp has to be renewed; as lamps of only 4 volts are used, the tube can be touched freely. The instruments used by the operator are Ericsson's head-telephone and breast-microphone, as shown in figs. 3 and 8; these admit of the operator moving about freely.

The glow lamp bank, fig. 10, is divided into panels with 100 lamps each; in the actual case only four of the eight panels are filled. For the sake of comparison, three panels are fitted with white glass discs, and one with green; the latter, however, appears to possess advantages over the white. These glow lamps are fitted as on the calling board.

The relays for each section are located in a cupboard with glass doors, so as to exclude the dust; the relays, as shown in fig. 11, are mounted in sets of 10 on a base board, which can be taken out. The adjustment and cleaning of the contacts can be readily carried out from in front. The connection wires seen in the illustration are only provisional, and would be replaced by spring contacts, so that a base-board could be exchanged for another in a few seconds. The back contact springs are fixed on the front of the back of the cupboard, while the leads run along behind it.

As follows from the description of the working, the operator has to go through the following steps:—

A.—*If the line wanted is engaged.*

(*a*) At the calling board, *a*:

1. First movement: Peg the jack of the calling subscriber, 12.
2. Communication: "Here." Reception of the number called, *b* 15. Observation of the glow lamp bank to see if *b* 15 is disengaged, and reply, "Line *b* 15 is engaged."
3. Second movement: Unpeg the jack, 12.

B.—*If the line wanted is disengaged.*

(*a*) At the calling board, *a*:

1. First movement: Peg the jack of the calling subscriber, 12.
2. Communication: "Here." Reception of the number called *b* 15. Observation of the glow lamp bank to see if *b* 15 is disengaged.
3. Second movement: Depress speaking key, *b*, and call up the connecting operator, *ab*: "*b* 15 on *a* 12."
4. Third movement: Unpeg the jack, 12.

(*b*) At the connection board, *ab*:

5. Fourth movement: Peg the jack, *b* 15.
6. Fifth movement: Peg the jack, *a* 12.
7. Sixth movement. Unpeg the jack, *a* 12.
8. Seventh movement. Unpeg the jack, *b* 15.

If the lines are very busy, the movement, A_3, of the operator for one call, and A_4 for the next call, are really reduced to one, and similarly for B_4 and B_1; therefore the work at the exchange, if the line wanted is disengaged, consists of six movements for putting one communication through and interrupting it, whilst if the line wanted is engaged, it consists of only one movement.

In order to ensure correct working, a control is provided for every communication. If at either of the movements, A_1 or B_1, a wrong jack is pegged, the warning lamp does not go out, and the operator is at once aware of his error, and need not call "Here" several times over the wrong line. During the movement, B_3, the subscriber is still connected to the operator, and therefore hears the repetition of his instructions, and can at once correct any mistake made by saying, "That's wrong," and repeating his instructions. Moreover, the calling operator can control the connecting operator, and see whether the instruction, "*b* 15 on *a* 12," has been properly carried out, for in this case *b* 15 must appear on the glow lamp bank, and *a* 12, which is already alight, must not go out when he takes his peg out of jack *a* 12.

In what has been said the sections have been designated by the letters of the alphabet; but as some letters, such as *b*, *p*, *m*, *n*, &c, are difficult to distinguish by telephone, the letters themselves are not used in practice, but are replaced by short distinctive names which begin with them.

As regards the arrangement of the boards, it is evident that only the call board and the glow lamp bank need be in the same room, while the other portions of the installation may be in different ones.

* Reproduced from *Electrotechnische Zeitschrift* at the request of the author.

It will be advisable, in the case of large exchanges, to place the connection board in one room, and the call board, lamp bank and relay board in another.

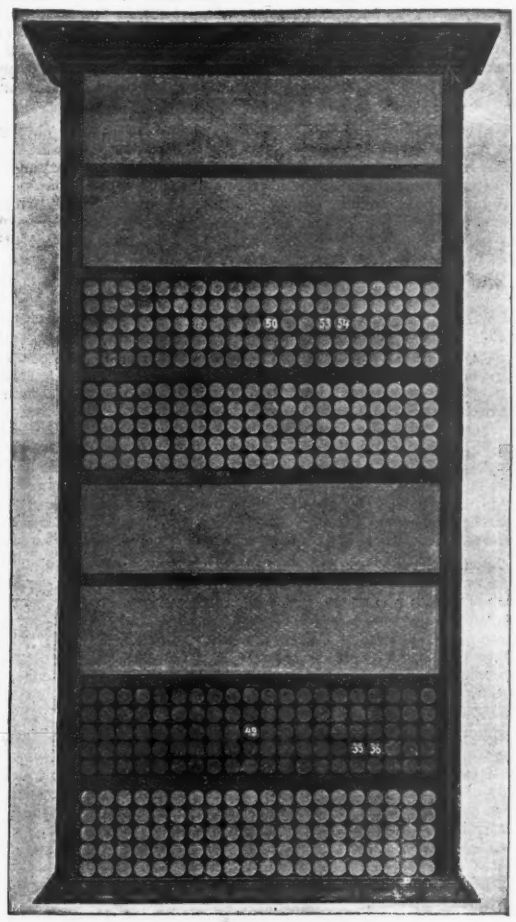


Fig. 10.

In an exchange with 40,000 subscribers, the call boards will require a hexagonal room, about 60 feet across, the call boards being arranged in four series, parallel to the walls, and so that each series towards the middle of the room would stand 20 inches higher than the one outside it; all the operators, therefore, who turn their backs to the middle of the room, have an unobstructed view of the walls in front of them. The six walls are covered by four complete glow lamp banks, so each bank, with 10,000 glow lamps, covers a wall and a half.

With such an arrangement the greatest distance from any operator to the furthest glow lamp which he has to watch will not exceed 28½ feet, at which the signals are plainly perceptible.

With the arrangement of connection boards on page 170, August 7th, 20 sections will give 211 tables; each of these would have 30 double communication cords, or a total of 6,330 cords, which suffice for 40,000 subscribers, even taking into account an increase in the business. This number, divided into 20 sections, gives 2,000 subscribers per section. The connection boards arranged according to the table on page 171, August 7th, but modified by placing all the boards of the first four series to the left of the vertical line lower down in the vacant space to the left of the last four series, as shown below, would require a room about 60 feet by 67 feet.

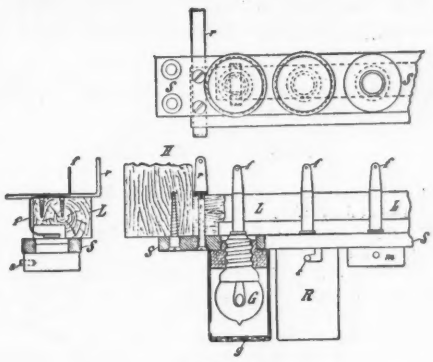


Fig. 9.

| | | |

The number of jacks in the one exchange would be about 500,600, while in the seven exchanges it would be about 2,500,000.

The number of operators on duty at one time would be 411 as a maximum, against 1,000 to 1,200 on the multiple system, assuming the distribution of tables followed in Berlin, where there are 66 or 67 subscribers, and 10 to 12 cords per table.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

NEW PATENTS.—1896.

16,551. "Commutator protector." A. B. Roxburgh and T. D. Green. Dated July 27th.

16,566. "Improvements in or relating to electric bells or signals." J. Rendell. Dated July 27th.

16,592. "Connecting plug for telephone cords." B. Hawke, and the London Electric Wire Company. Dated July 27th.

16,597. "Improvements in and relating to primary batteries." R. M. J. Hurtrey and P. Germann. Dated July 27th.

16,608. "An improvement relating to magnetic compasses." J. D. R. Blain. Dated July 27th.

16,629. "Improvements in the construction of electric cables." J. D. R. Blain and W. J. Pawson. Dated July 27th.

16,644. "Improvements in the means of attaching metal contacts in electrically controlled and other gas burners." F. R. Boardman. Dated July 28th.

16,657. "Improvements in means or apparatus for the measurement of electric energy." G. A. J. Telge. Dated July 28th.

16,683. "Improvements in alternating electric current transformers." J. A. McMullen. Dated July 28th.

16,726. "Improvements in electrodes for secondary batteries." F. W. Schneider. Dated July 28th.

16,729. "Improvements in the manufacture of caustic soda and other alkaline hydrates and compounds by electrolysis." L. G. Attenborough and E. A. Sulman. Dated July 28th.

16,737. "Improved apparatus for generating or collecting electric energy." J. D. R. Blain. Dated July 28th.

16,790. "Telegraph wire reel." H. Ehricht. Dated July 29th. (*Complete.*)

16,852. "Improvements in electrolysis." G. Poore. Dated July 29th. (*Complete.*)

16,894. "Improvements in and relating to instruments for measuring electric currents." J. Finlayson. Dated July 30th.

16,916. "Apparatus for obtaining oxygen and hydrogen from steam by electrolysis." E. Strzelecky. Dated July 30th.

17,001. "Electrolytic manufacturing of cyanide of alkali." R. Pauli. Dated July 31st.

17,025. "Improvements in incandescence electric lamps." T. A. Rose, and Rose & Bird, Limited. Dated July 31st.

17,044. "Improvements in and connected with apparatus for lighting and extinguishing gas jets by the means of an electric current." W. Edwards. Dated July 31st.

17,088. "Improvements in electric batteries." H. W. Headland. Dated August 1st.

17,093. "Improvements in counter-balance weights for electroliers, gasoliers, and other suspended fittings." H. W. G. Plunkett. Dated August 1st.

17,098. "An automatic electrical switch or exchange." A. Sautter and J. J. Sautter. Dated August 1st.

17,101. "Improved electrical switch." J. H. Field. Dated August 1st.

17,122. "Improvements in metallic junction-boxes and means for uniting metal conduit tubes thereto and to each other." H. H. Lake. (E. T. Greenfield, United States.) Dated August 1st. (*Complete.*)

17,123. "Improvements in insulating joints for metal or armoured conduit tubes, more especially suitable for electrical conductors." H. H. Lake. (E. T. Greenfield, United States.) Dated August 1st. (*Complete.*)

17,124. "Improvements in and connected with conduits, more especially suitable for electrical conductors." H. H. Lake. (E. T. Greenfield, United States.) Dated August 1st. (*Complete.*)

17,125. "Improvements in conduit tubes, more especially suitable for electrical conductors." H. H. Lake. (E. T. Greenfield, United States.) Dated August 1st. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free*, 8½*d.* (*in stamps.*)]

1895.

10,418. "Improvements in or connected with time recording apparatus for consumption of electric current." R. Wende. Dated May 27th, 1895. Relates to an apparatus which records the time during which an electric current is supplied from a central station to the place of consumption. The apparatus consists of a disc provided with semi-circular incisions and connected at a certain point with the device for closing the circuit, the said disc being so arranged that when the circuit is closed the upper extension of the pendulum of the clockwork mechanism can move freely within the semi-circular incisions, whereas when the circuit is interrupted, the outwardly curved part of the disc stops the pendulum. The pointer of the clock is prevented from turning in an opposite direction and stopping the pendulum while utilising the current, by means of a ratchet wheel and pawl. 2 claims.

15,114. "Improvements in electric current meters." C. Erben and E. Bergmann. Dated August 10th, 1895. Comprises an electric meter in which fixed coils traversed by the current to be measured influence the oscillation of a balance spring and thereby the working of a clock. The balance spring is connected with a second spring by means of a lever arm, whose length is regulated with coils or magnets moved by the current to be measured so as to take advantage of the gain and loss of time by the clock. 2 claims.

1896.

477. "Improvements in electrical storage accumulators." C. N. Stewart. Dated June 7th, 1896. Relates to an electrical accumulator element formed of a grid or other open form of contact or collector of conductive material rolled upon itself in an open spiral, and embedded in active material packed into and around it, and contained in a perforated receptacle of insulating material and of tubular form closed at bottom. The element is provided with a projecting tung which stands vertically from the innermost edge of the element, and is sheathed in a tube of insulating material, so as not to be acted upon by the electrolyte. This tung is shouldered near the top, and the end passed through a hole in a lead cross bar and burnt over on top of the bar, thus making a solid conductive joint. 1 claim.

7,882. "Improvements in regulating alternating current electric motors of the induction type." J. Devonshire. (W. B. Potter, United States.) Dated April 14th, 1896. Relates to the regulation electric motors in a complicated system of an electric railway on the three-phase system, by use of the resistance control. The fields are connected permanently in multiple between the supply lines and the circuit of each armature is closed through a variable resistance, these resistances are connected so as to be operated simultaneously and varied to regulate the speed of the motors. 2 claims.

8,659. "Improvements in paste carrying plates for electric accumulations." F. W. Schneider. Dated April 24th, 1896. Relates to paste carrying plates for electric accumulators, and consists of a grate like body consisting of parallel bars furnished with cross pieces placed obliquely to the plate surface provided with vertical parts and uniting the longitudinal bars of the plate together, forming therewith hollow spaces for receiving the filling. These plates afford a good conductivity and have special qualities of stiffness and hardness and are especially suitable for locomotive purposes. 1 claim.

8,695. "Improvements in electrodes for accumulators." W. Majert. Dated April 24th, 1896. Obviates the inconvenience which arises when the active mass of electrodes is placed in the metal holding frames and subjected to the charging currents whereby it expands considerably and causes the plates to bulge out, this is done by providing a hollow space between the active mass in the frame sufficient to allow expansion of the mass, which space is formed by placing in the frame before the active material is inserted, a layer of a soluble substance; this is dissolved and washed out through small holes in the frame after the insertion and hardening of the active material. 1 claim.

10,124. "Improvements in systems of distribution of alternating electric currents." J. Devonshire. (C. P. Steinmetz, U.S.A.) Dated May 12th, 1896. Relates to an alternating current system of distribution comprising transformers having their primaries connected in delta and their secondaries in Y and a neutral or equalising wire extending from the common junction of the secondaries only. By this arrangement so long as the primary voltages are consistent, the secondary potentials also are constant irrespective of the balance of load upon the secondaries. 2 claims.

10,189. "Improvements in carbon brush holders for electric motors or dynamos." F. H. Royce and E. A. Claremont. Dated May 13th, 1896. Relates to a means for retaining or holding a carbon brush so as to cause constant and unvarying pressure on the commutator. This is attained by the combination of a bracket for holding the brush, a spring for keeping brush in contact, a pivoted lever for holding said spring, and a spindle affixed to the bracket and passing through the lever, and having a screw nut with a coiled spring placed between said nut and lever and regulated by said nut; thus a constant pressure is maintained by the brush irrespective of the diminution in its length by wear. 1 claim.

12,650. "Improvements in thermo-electric generators." H. B. Cox and the Cox Thermo-Electric Co., Ltd. Dated June 9th, 1896. "Relates to generators wherein the electric current generating element is easily removable from the supporting or enclosing parts. The active element is formed of rings of metal properly arranged and connected; the whole being then coated with a plastic refractory material such as fire clay so as to make the rigid tube for conducting wires passing through the coating. The casing and active element have a space between them so as to form a water jacket through which cold water can be circulated to keep one set of the thermo-electric junctions cool, the other set being heated in a suitable manner by gas flowing for example up the inside of the element. 5 claims.